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Environmental Protection
Agency

Office of
Emergency and
Remedial Response

EPA/ROD/R07-89/026
September 1989

EPA

Superfund Record of Decision:

Solid State Circuits, MO

50272-101

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16. Abstract (Limit: 200 words)

The Solid State Circuits (SSC) site, a former industrial and manufacturing facility, is located in Republic, Missouri, approximately twelve miles southwest of Springfield. The approximately 1/2-acre site has residential areas to the east, west, and south, and light industry and warehousing to the north and south. The city of Republic obtains its drinking water from three municipal wells (2,3, and 4) which draw from the deepest of three underlying aquifers. The site currently consists of a former manufacturing building, two air strippers, and an excavated yard area (from prior removal actions). Uses of the facility since 1902 included milling, refrigeration, printed circuit board manufacturing, and photoprocessing, as well as other, unknown, activities. The major wastes generated appear to have been cleaning solvents used in the circuit board process and wastewaters from the circuit board activities. Sampling by the Missouri Department of Natural Resources (MDNR) in 1982 revealed contamination with TCE in Municipal Well Number 1, 500 feet south of the site. The SSC site was identified as a possible source. Subsequent actions by MDNR, EPA, SSC, and the city included pumping tests, several major soil and debris excavations and removals (thereby eliminating the source of contamination), and taking Municipal Well Number 1 out of service. This Record of Decision addresses the ground water contamination found in all three aquifers. Contamination was found in the ground water, water in utilities, and air. The primary contaminants of concern are VOCs, particularly TCE. (See Attached Sheet)

17. Document Analysis a. Descriptors

Record of Decision - Solid State Circuits, MO
First Remedial Action - Final
Contaminated Media: gw
Key Contaminants: VOCs (TCE)

b. Identifiers/Open-Ended Terms

c. COSATI Field/Group

18. Availability Statement	19. Security Class (This Report) None	21. No. of Pages 78
	20. Security Class (This Page) None	22. Price

(See ANSI-Z39.18) *See Instructions on Reverse* OPTIONAL FORM 272 (4-77) (Formerly NTIS-35) Department of Commerce

16. Abstract (continued)

The selected remedial action for this site includes ground water pumping and onsite treatment using existing air strippers, discharging the treated water to a POTW, plume control via pumping, and BACT (as required) for air emissions; and air and water monitoring. The estimated present worth cost for this remedial action is $4,629,000, which includes an annual O&M cost of $445,300.

DECLARATION FOR THE RECORD OF DECISION

SITE NAME AND LOCATION

Solid State Circuits Site
Republic, Missouri

STATEMENT OF BASIS AND PURPOSE

This decision document presents the selected remedial action for the Solid State Circuits Site in Republic, Missouri, chosen in accordance with the Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA), as amended by the Superfund Amendments and Reauthorization Act of 1986 (SARA) and, to the extent practicable, the National Contingency Plan, 40 C.F.R. Part 300. This decision is based on the Administrative Record file for this site.

The State of Missouri concurs on the selected remedy. A letter from the State of Missouri stating their concurrence is included in this Record of Decision package.

ASSESSMENT OF THE SITE

The site has three aquifers that are contaminated with hazardous substances, primarily trichloroethene (TCE). Estimates of the volume of contaminated water are as follows: 15 million gallons in the unconsolidated/fractured shallow bedrock system, 790,000 gallons in the shallow bedrock system, and 42 million gallons in the deep bedrock system.

Actual or threatened releases of hazardous substances from this site, if not addressed by implementing the response action selected in this ROD, may present an imminent and substantial endangerment to public health, welfare, or the environment.

DESCRIPTION OF THE REMEDY

The selected remedy addresses only the contamination of the ground water aquifers. Previous response actions removed the soil as a source of continuing contamination.

The major components of the selected remedy include:

- Extraction of the contaminated ground water by using existing and new wells;
- Onsite treatment of the extracted ground water using two existing air strippers;

- Discharge of treated water to the City of Republic sewer system to receive further treatment at the Publicly Owned Treatment Works;

- City ordinance to prevent construction of drinking wells in or near the contaminant ground water plumes; and,

- Continued monitoring to determine the effectiveness of the remedy.

These response actions would prevent future ingestion/dermal contact of hazardous substances by containing the contaminated ground water plumes, removing the contamination, and restoring the aquifer to acceptable goals for unrestricted use.

STATUTORY DETERMINATIONS

The selected remedy is protective of human health and the environment, complies with Federal and State requirements that are legally applicable and appropriate to the remedial action, and is cost effective. This remedy utilizes permanent solutions and alternative treatment technologies to the maximum extent practicable and satisfies the statutory preference for remedies that employ treatment which reduce toxicity, mobility, or volume as a principal element.

A review will be conducted within five years after commencement of remedial action to ensure that the remedy continues to provide adequate protection of human health and the environment.

9-27-89
Date

Morris Kay
Morris Kay, Regional Administrator
Environmental Protection Agency, Region VII

JOHN ASHCROFT
Governor

G. TRACY MEHAN III
Director

STATE OF MISSOURI
DEPARTMENT OF NATURAL RESOURCES

Division of Energy
Division of Environmental Quality
Division of Geology and Land Survey
Division of Management Services
Division of Parks, Recreation,
and Historic Preservation

OFFICE OF THE DIRECTOR
P.O. Box 176
Jefferson City, MO 65102
314-751-4422

September 25, 1989

Mr. Morris Kay
Regional Administrator
U.S. EPA Region VII
726 Minnesota Avenue
Kansas City, KS 66101

Dear Mr. Kay:

The Missouri Department of Natural Resources has reviewed the Record of Decision (ROD) for the Solid State Circuits, Inc. site in Republic, Missouri. The department concurs with the selected remedy for the site detailed in the ROD.

If you have any questions regarding this matter, please do not hesitate to contact me.

Very truly yours,

DEPARTMENT OF NATURAL RESOURCES

G. Tracy Mehan, III
Director

GTM:jsp

cc: Mr. Robert Morby, EPA

RECORD OF DECISION

SOLID STATE CIRCUITS SITE

REPUBLIC, MISSOURI

Prepared by:

U.S. Environmental Protection Agency

Region VII

Kansas City, Kansas

SEPTEMBER 1989

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

SECTION 1.0 SITE NAME, LOCATION, AND DESCRIPTION

Republic is located in southwest Missouri approximately twelve miles southwest of Springfield, Missouri as shown on Figure 1. The Solid State Circuits (SSC) site is located at the southeast corner of Elm and Main streets in Republic, Greene County, Missouri, as shown on Figure 2. Republic's 1986 population was estimated at 6,139 with a projected population of greater than 10,000 by the year 2005.

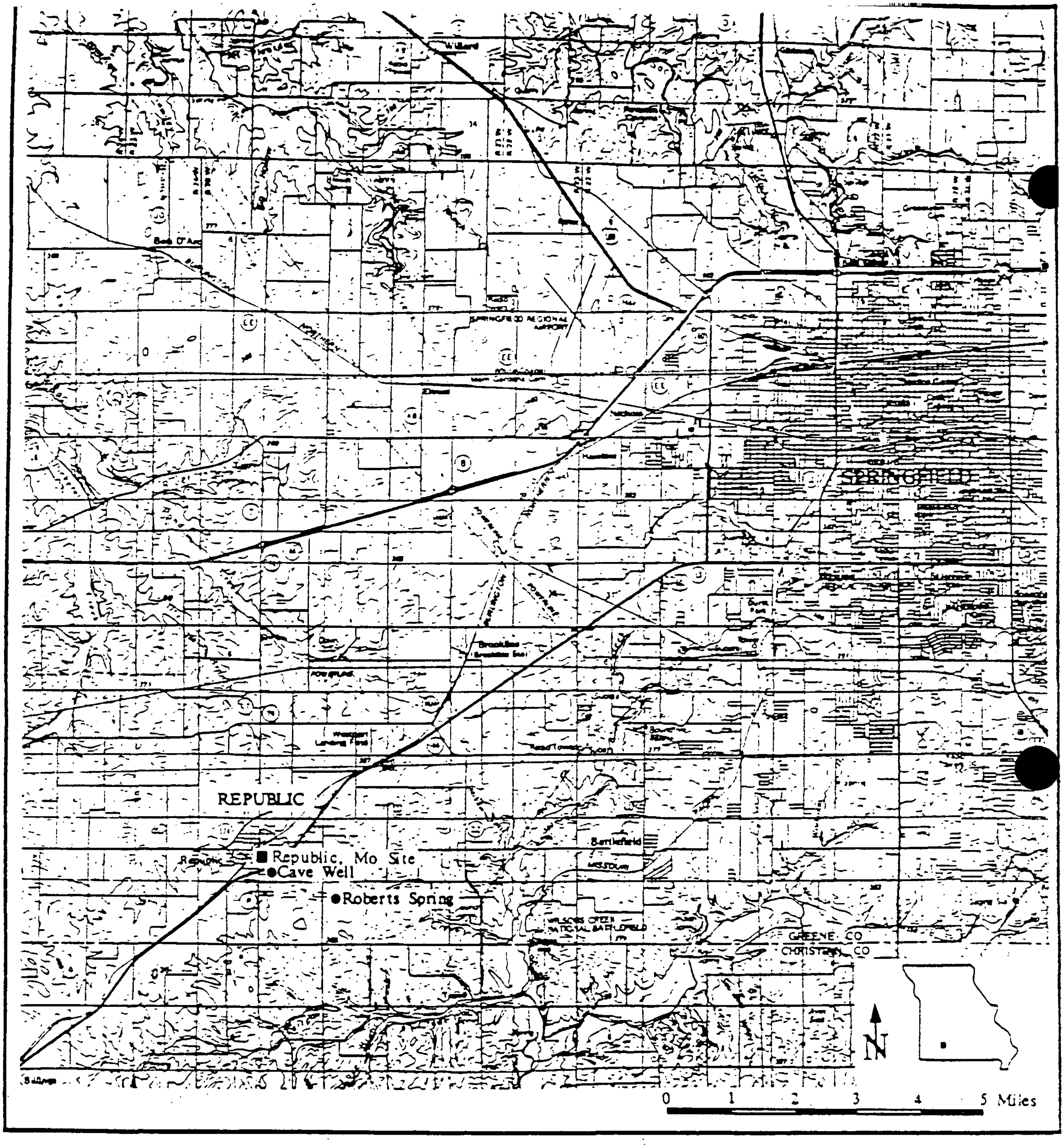
Currently, the SSC site is a lot of approximately 21,000 square feet (1/2 acre) enclosed within a six foot high chain link fence. The only permanent building currently on the lot houses two air stripper towers. The surrounding land use is urban. Single family dwellings exist to the east and two blocks to the west and south. Light industry and warehousing exists due south and north of the site. The City of Republic obtains its drinking water from three municipal wells drawing from the deep bedrock aquifer. Municipal Well Number 2 is approximately 2,100 feet east-southeast of the site, Municipal Well Number 3 is 4,900 feet northeast of the site, and Municipal Well Number 4 is 4,700 feet west of the site. Municipal Well Number 1, not in service, is approximately 500 feet south of the site. The location of the site to the municipal wells is shown on Figure 2.

SECTION 2.0 SITE HISTORY AND ENFORCEMENT ACTIVITIES

2.1 Site History

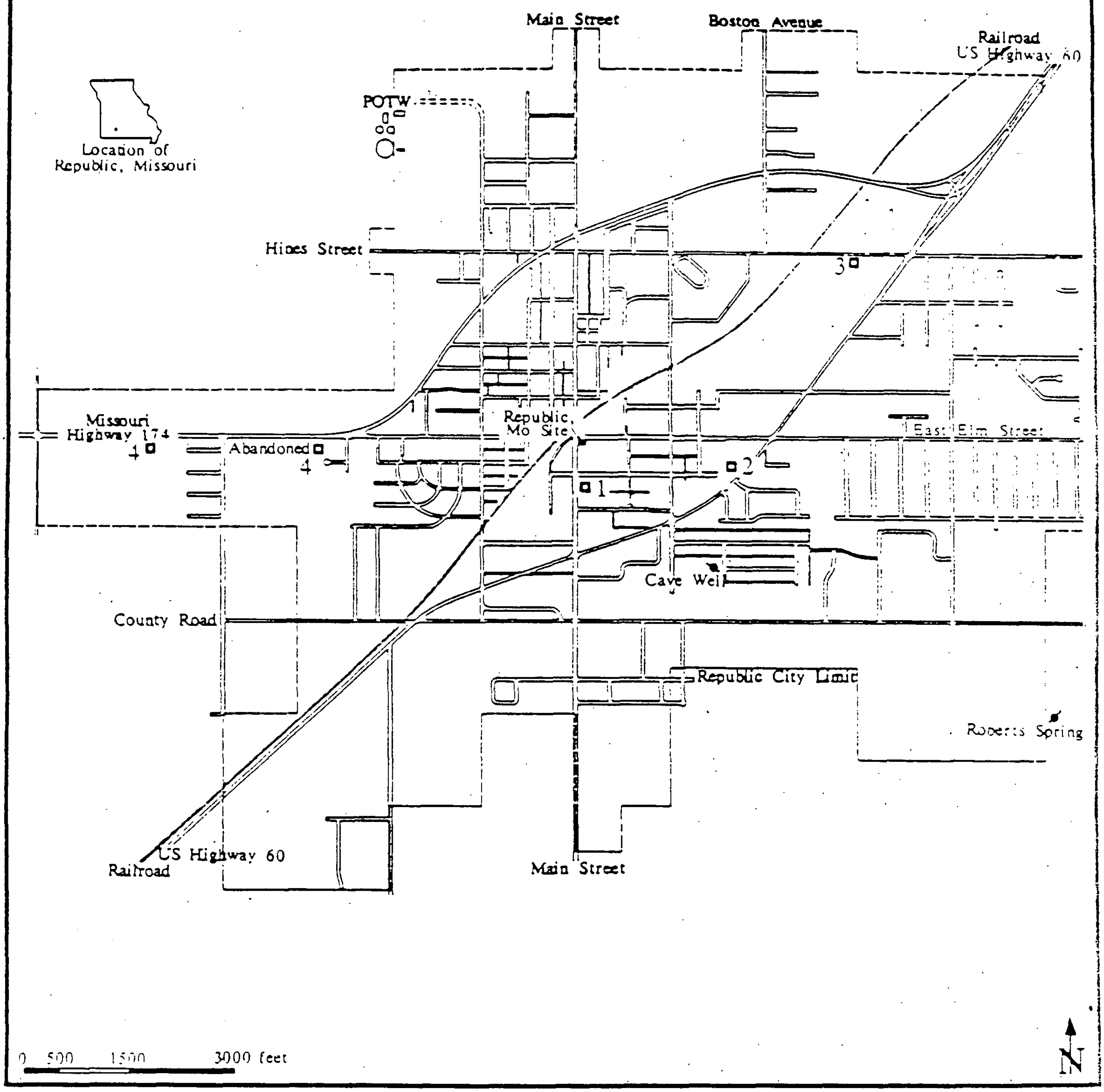
The SSC site is a former industrial and manufacturing site which was leased and operated by a number of business concerns through the years. The former plant building apparently was constructed prior to 1902 and was originally operated by a milling company. Based on a review of historical photos, the building extended the entire length of the block from Mill to Elm Street. The building was one story except for the northern third, which was four stories high. Sometime between 1902 and 1937, a cold (refrigeration) plant began operations in the building, at least in its northern end. From the period of 1930 to 1968, little is known about specific uses of the former plant building and land, or what chemicals may have been used.

Solid State Circuits, Inc. (SSC) began manufacturing operations in the northern end of the building in 1968 and continued until November, 1973. SSC manufactured printed circuit boards in the plant, and used trichloroethene (TCE) as a cleaning solvent in portions of its manufacturing process. Reliable volume estimates of TCE and other chemicals used at the site are not available. The SSC plant waste water reportedly contained copper, chromium, iron, ammonium, manganese, and zinc; however, the reliability of this information is not known. Wastes were



REGIONAL LOCATION OF REPUBLIC, MISSOURI

FIGURE 1



MAP OF REPUBLIC, MISSOURI

CW- _ Municipal Well
Cave Well
Roberts Spring

FIGURE 2

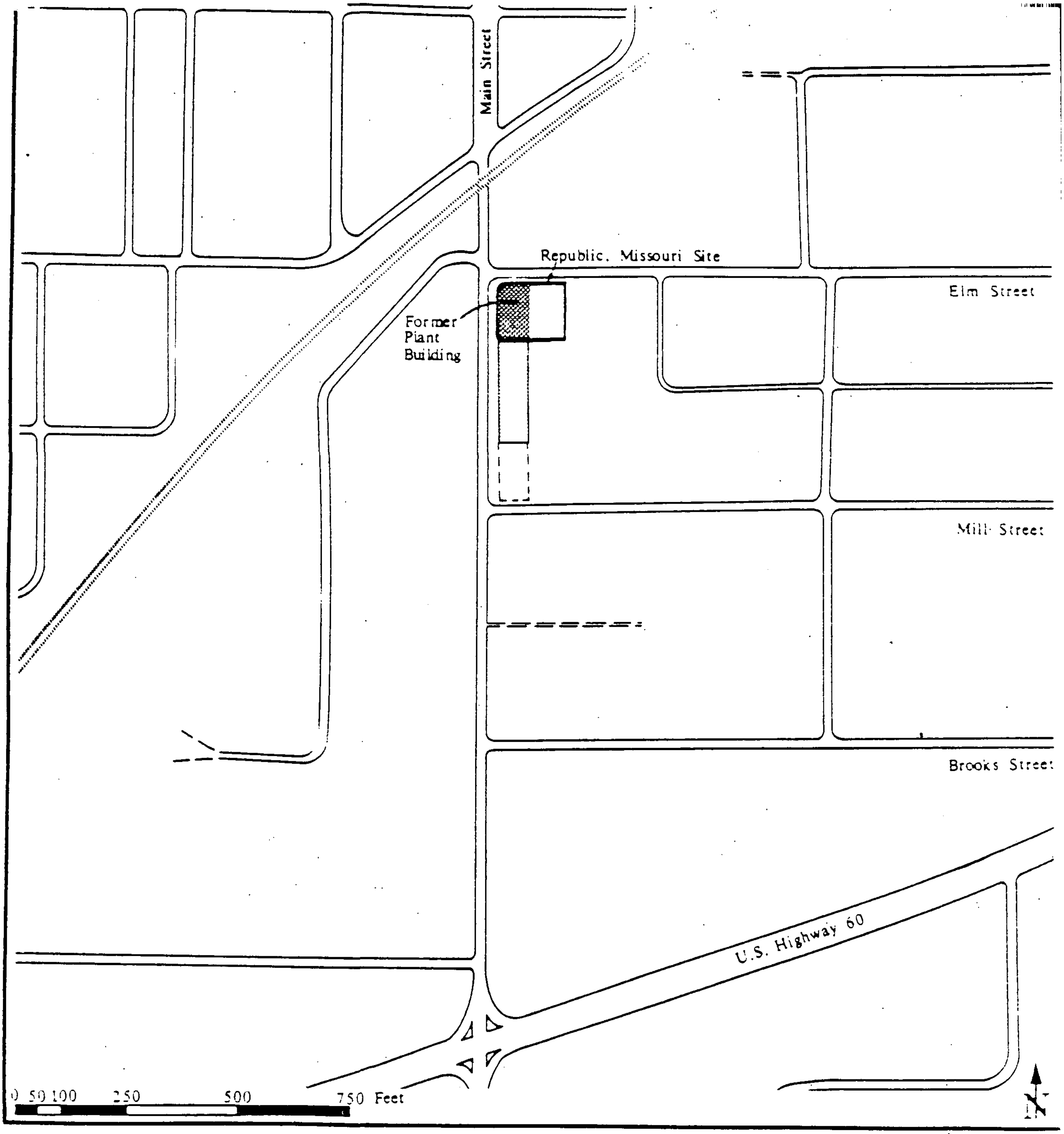
reported to have been temporarily stored in a sump pit in the basement. A capped well was also located in the basement, which may have served the city as a water supply.

In November 1973, SSC moved its manufacturing operations to Springfield, Missouri. The SSC site was occupied thereafter by Micrographics, Inc., a photographic processing firm, and possibly other businesses until 1979. Micrographics, Inc. occupied the northern end of the building. Other businesses which may have operated on the premises and the chemicals they may have used could not be determined. In November 1979, the northern part of the building was destroyed by fire. Some witnesses have stated that the basement had a strange odor and everything appeared green and corroded prior to the fire. During the fire, other witnesses stated they saw several fifty-five gallon drums in the basement; however, investigative excavation did not confirm this. After the fire, the damaged portion of the structure was demolished and the debris pushed into the basement under the remaining portion of the building. The vacant lot was used for parking occasionally.

Mr. Nicholas Weinsaft purchased the former SSC property in 1976. Currently, the remaining southern portion of the building and the vacant lot are owned by Crane Manufacturing Company of Crane, Missouri (see Figure 3). The only known tenant of the southern portion of the building is a factory outlet store.

2.2 Removal History

In June 1982, the Missouri Department of Natural Resources collected samples from the City of Republic's three municipal wells for analysis of volatile organic compounds as part of EPA's National Synthetic Organic Chemical Survey. A TCE level of 15 micrograms per liter (ug/l) was detected in Republic's Municipal Well Number 1, which is located 500 feet south of the former SSC manufacturing site. The detected concentration was below Missouri's health based criteria, at that time, of 27 ug/l in drinking water. Additional sampling by MDNR confirmed the presence of TCE in this well, and it was taken out of service sometime between July 1983 and March 1984. The exact date is not known. Municipal Wells Numbers 2 and 3 were not contaminated with volatile organic compounds and have remained so to the present. Municipal Well Number 4 was brought on-line in 1988, and it also has been sampled and found to be uncontaminated by volatile organic compounds. MDNR collected and analyzed samples from the three uncontaminated municipal wells on a monthly basis throughout the remedial investigation and the feasibility study. In April, 1983, MDNR initiated response actions to identify possible contaminant sources and to further investigate the TCE occurrence in Municipal Well Number 1. The former SSC manufacturing plant was identified as one potential source of the TCE.



LOCATION OF THE REPUBLIC, MISSOURI SITE

▩ Former Plant Building
☐ Existing One-Story Building
⬚ Former Extent of One-Story Building

Prepared for: Solid State Circuits, Inc. 203B/23MAY89S Project Manager: Steven D. Chatman

Geraghty & Miller, Inc. Figure 3

In 1984, MDNR conducted response activities at the SSC site; the activities were divided into four separate phases. During Phase I, MDNR sampled Roberts Spring, a local well designated as Cave Well, and Municipal Well Numbers 2 and 3, and pumped Municipal Well Number 1 for 10 days and collected samples from the well. During continued pumping of Municipal Well Number 1, the TCE concentration decreased within a five day period from 140 ug/1 to 25 ug/1. TCE was detected in the samples from Municipal Well Number 1 only.

During Phase II, SSC financed the excavation of approximately 1,500 cubic yards of soil and debris from the former building basement area and conducted extensive soil and water sampling in and around the basement area. During the excavation, only three containers were discovered. There was one crushed fifty-five gallon drum, an empty crushed five gallon can, and a cracked thirty gallon cylinder. Additional features discovered in the basement area were an old basement well about 540 feet deep, an elevator shaft, a sump of unknown function, and a sewer box. TCE was found in samples of the fill dirt and rubble excavated from the basement, in water from the basement, in the shallow ground water outside the basement area, and in ground water samples taken at various depths in the 540-foot well. Approximately 75 to 150 cubic yards of excavated soil and debris

were transported from the site and disposed at Bob's Home Service in Wright City, Missouri. The remaining soil, somewhere between 1,325 and 1,425 cubic yards, was temporarily stored on site.

During Phase III, MDNR pumped Municipal Well Number 1 for 24 hours to monitor its effect on the basement well and an offsite monitoring well, but the results were inconclusive. Two ground water samples were collected from Municipal Well Number 1.

During Phase IV, SSC financed additional excavation and sampling beneath the basement floor and installed three shallow monitoring wells. Several sub-basement pipes were encountered: a cast iron pipe, a metal lined concrete culvert, and a clay tile pipe. The basement well had two holes in the casing at depths of four and eight feet beneath the basement. The basement well appeared to receive recharge water from the surface drainage system, specifically from the clay tile pipe. Samples showed continued high levels of TCE in the SSC basement well, the shallow ground water, and the soil beneath the site. From October to November, 1984, MDNR cleaned out the basement well, recased it to a depth of 40 feet, and installed a submersible pump. Due to a poor recharge flow of 0.75 gallons per minute, the well was determined to be a poor candidate for use in recovering contaminated ground water.

On April 5, 1985, the EPA Regional Administrator signed an Action Memorandum which allowed EPA to undertake an immediate removal at the site. These activities were undertaken to mitigate the potential threat to the public health and the environment posed by the approximately 1,400 cubic yards of contaminated soil that remained on site. The actual removal action began on April 18, 1985. Samples were taken of the stockpiled soil and of the entire site area to define any additional areas requiring excavation. Additional excavation of the basement area occurred from late April to mid-May, 1985. Excavation of soil was most extensive in the southern portion of the basement where TCE concentrations were found to be the highest. Excavation was terminated when bedrock was encountered. Approximately 800 cubic yards of contaminated soil was removed from beneath the basement floor. Four new shallow offsite monitoring wells were installed from May 6 to May 8, 1985.

Site operations were suspended from May 17 to August 27, 1985 when it was discovered that the original disposal facility for the contaminated soil was not in compliance with Resource Conservation and Recovery Act (RCRA) requirements. In time, a suitable disposal site was selected, and approximately 1,990 tons of contaminated soil and debris was disposed at the Adams Center Landfill near Fort Wayne, Indiana. Transport of contaminated soil began on September 4 and was completed on October 3, 1985. In addition to the soil removal activities, two recovery/ monitoring wells were installed onsite in October. One well, completed at a depth of 331 feet (designated REM-2), was constructed on the west side of the site within the perimeter of the former basement area to monitor the shallow bedrock aquifer. A second well, completed at a depth of 600 feet (designated REM-1), was constructed on the east side of the site outside the perimeter of the former basement area to monitor the deep bedrock aquifer. Pumps were installed in both wells on October 30, 1985. The old basement well was sealed. The excavated basement area was filled with 85 tons of gravel forming a one foot layer. A sufficient quantity of clean fill dirt was then placed over the gravel to bring the excavated area up to grade. The wooden fence around the site was replaced with a chain-link fence to improve site security, and final grading and seeding of the area took place on October 31, 1985.

On October 7, 1985, MDNR announced that they would be assuming long-term responsibility for the remedial cleanup of the SSC site. The EPA placed the site on the National Priorities List (NPL) on June 10, 1986.

2.3 Enforcement History

On June 15, 1983, MDNR notified all known potentially responsible parties (PRPs) of the problem existing in Republic and invited them to a meeting to discuss voluntary remediation of the site. On December 2, 1983, MDNR sent Notices of Imminent Hazard to the potentially responsible parties. On December 14, 1983, SSC and Paradyne, who had not been notified as PRPs, stated that they had retained the services of a nationally recognized ground water company to perform a preliminary study of the problem.

On August 26, 1983, MDNR notified the property owner, Mr. Nicholas Weinsaft, that the site was proposed for inclusion on the Registry of Confirmed Abandoned or Uncontrolled Hazardous Waste Disposal Sites in Missouri. On September 15, 1983, the property owner appealed the listing on the basis that he wished to either delete the property from the Registry or decrease the size to be included on the Registry. The MDNR and Mr. Weinsaft reached an agreement on October 22, 1984, concerning the property to be placed on the Registry. The Registry would not include property still in use by Mr. Weinsaft. The property to be included was located immediately adjacent to and against the north wall of the building owned by Mr. Weinsaft. The SSC site was placed on the Registry on February 22, 1985.

On January 25, 1985, the EPA issued a letter to the PRPs informing them of their intent to issue an Administrative Order to include response actions to abate the threat posed by the site. Alternatively, PRPs could enter into an Administrative Order on Consent with EPA to perform the necessary cleanup work. On March 6, 1985, the EPA Regional Administrator issued a CERCLA 106 Administrative Order to identified responsible parties. SSC and Paradyne contested the Administrative Order. However, on March 14, 1985 a federal judge ruled in favor of EPA. EPA approved the Action Memorandum on April 5, 1985 for an immediate removal. On March 1, 1988, SSC settled with EPA in the amount of $945,000, for costs incurred by the United States when SSC failed to respond to EPA's March 6, 1985 Administrative Order.

On February 25, 1985, the Attorney General's Office of the State of Missouri sent letters to all of the known PRPs demanding payment plus interest of the money expended by the state for response actions at the SSC site and offering them the opportunity to voluntarily take action to abate any releases or threatened releases from the facility. On April 30, 1985, the MDNR filed a civil action pursuant to CERCLA 107(a) and Missouri common law of public nuisance to 1) recover monies expended by the state at the SSC site, 2) seek recovery of future costs of remedial action at the site incurred by the state, and 3) seek damages for injury to natural resources of the State of Missouri. On May 28, 1985, SSC filed its Answer and Counterclaim against the state contending that the state should also be responsible for the TCE contamination since SSC allegedly had sought the advice of the Missouri Clean Water Commission on TCE disposal. On February 5, 1986, the Attorney General's Office notified three additional PRPs of their liability in regard to the state monies expended at the site and offered them the same opportunity to take voluntary action. On May 15, 1986, the MDNR and Solid State Circuits reached a settlement for past costs.

Following the April 30, 1985, civil action filed by the state, the MDNR and SSC entered into settlement negotiations. On November 20, 1986, MDNR entered into a partial consent decree on certain issues with SSC. SSC agreed to perform the remedial investigation/feasibility study (RI/FS), but left open the issue of liability for future costs, the state's determination of the total damages for alleged natural resources damage, and SSC's counterclaim against the state. SSC agreed to pay oversight costs to the MDNR to see that the RI/FS was implemented according to the approved work plan. On December 18, 1985, SSC submitted a plan to MDNR to conduct the RI/FS at the site. The RI/FS work plan was resubmitted in June 1986 in response to MDNR and EPA comments. After additional review and comment, MDNR/EPA approved the work plan in December, 1986. Implementation of initial RI activities began in late December, 1986, soon after approval, with the development of site investigation documents. SSC began field work for the RI/FS in June, 1987.

SECTION 3.0 <u>HIGHLIGHTS OF COMMUNITY PARTICIPATION</u>

The RI/FS and Proposed Plan for the Solid State Circuits site were released to the public on August 14, 1989. The administrative record file, which included the RI/FS reports and the Proposed Plan, was made available to the public at information repositories maintained at the Missouri Department of Natural Resources, in Jefferson City, the EPA Docket Room, in Kansas City, Kansas, and the Greene County Library - Republic Branch. The notice of availability for these documents was published in the <u>Republic Monitor</u> and the <u>Springfield News-Leader</u> on August 10, 1989. A public comment period was held from August 14, 1989 through September 5, 1989. In addition, a public meeting was held on August 24, 1989. At this meeting, representatives from the Missouri Department of Natural Resources (MDNR) and EPA answered questions about problems at the site and the remedial alternatives under consideration. At the meeting, citizens requested an extension of the public comment period. In response, MDNR and EPA extended the comment period through September 14, 1989 to allow citizens additional time to review the administrative record and the Proposed Plan. A response to the comments received during this period is included in the Responsiveness Summary, which is part of this Record of Decision.

This decision document presents the selected remedial action for the Solid State Circuits Site, in Republic, Missouri, chosen in accordance with CERCLA, as amended by SARA and, to the extent practicable, the National Contingency Plan. The decision for this site is based on the Administrative Record.

SECTION 4.0 <u>SCOPE OF RESPONSE ACTION</u>

To address the potential risks, the following remedial action objectives were identified for all three ground water aquifers:

* Prevent potential exposure to contaminated ground water;

* Protect uncontaminated ground water for future use by preventing further migration of the contaminated ground water plumes; and,

* Restore contaminated ground water for future use by reducing the contaminant concentrations to regulated or health-based levels.

SECTION 5.0 <u>SUMMARY OF SITE CHARACTERISTICS</u>

The Remedial Investigation (RI) field work, conducted by the PRP under MDNR oversight from mid 1987 to early 1989, included the following activities to define the types of contaminants at the site, potential routes of contaminant migration and routes of exposure, population and environmental areas that could be affected, and site-specific factors that may affect the remedial actions at the site:

- Sampling and analyses of onsite and offsite air, soil, surface water, utility water, and ground water;

- Installation of a network of monitoring wells into three hydrologic units: shallow unconsolidated/ fractured bedrock, shallow bedrock, and deep bedrock;
- Definition of a fracture zone in the bedrock through utilization of borehole and surface geophysical techniques;

- Performance of detailed slug tests, packer tests, and aquifer tests;

- Detailed monitoring and analyses of ground water levels and ground water chemistry in the area;

- Detailed monitoring and analyses of water samples from the Publicly Owned Treatment Works (POTW), sewer system, and Southwestern Bell manholes;

- Detailed analyses of site and municipal ground water pumpage;

- Partial implementation of a pilot program to treat contaminated ground waters;

- Development and implementation of numerical ground water flow and air flow models to assess past and present ground water flow directions and the possible dispersion of airborne contaminants, respectively;

- Completion of an offsite survey of private wells in the vicinity of the site; and,

- Air sampling and analyses in offsite, nearby residential basements.

Several types of contamination - volatile organic compounds (VOCs), organic compounds, and metals - were found during the RI in varying concentrations and in various media including ground water, water in utilities, surface soils, subsurface soils, and air both in utilities and above ground. The elevated concentrations of certain VOCs in the subsurface soils and ground water beneath the site indicate that a release of chemicals occurred at the site. The following section presents the results, conclusions and recommendations of the RI.

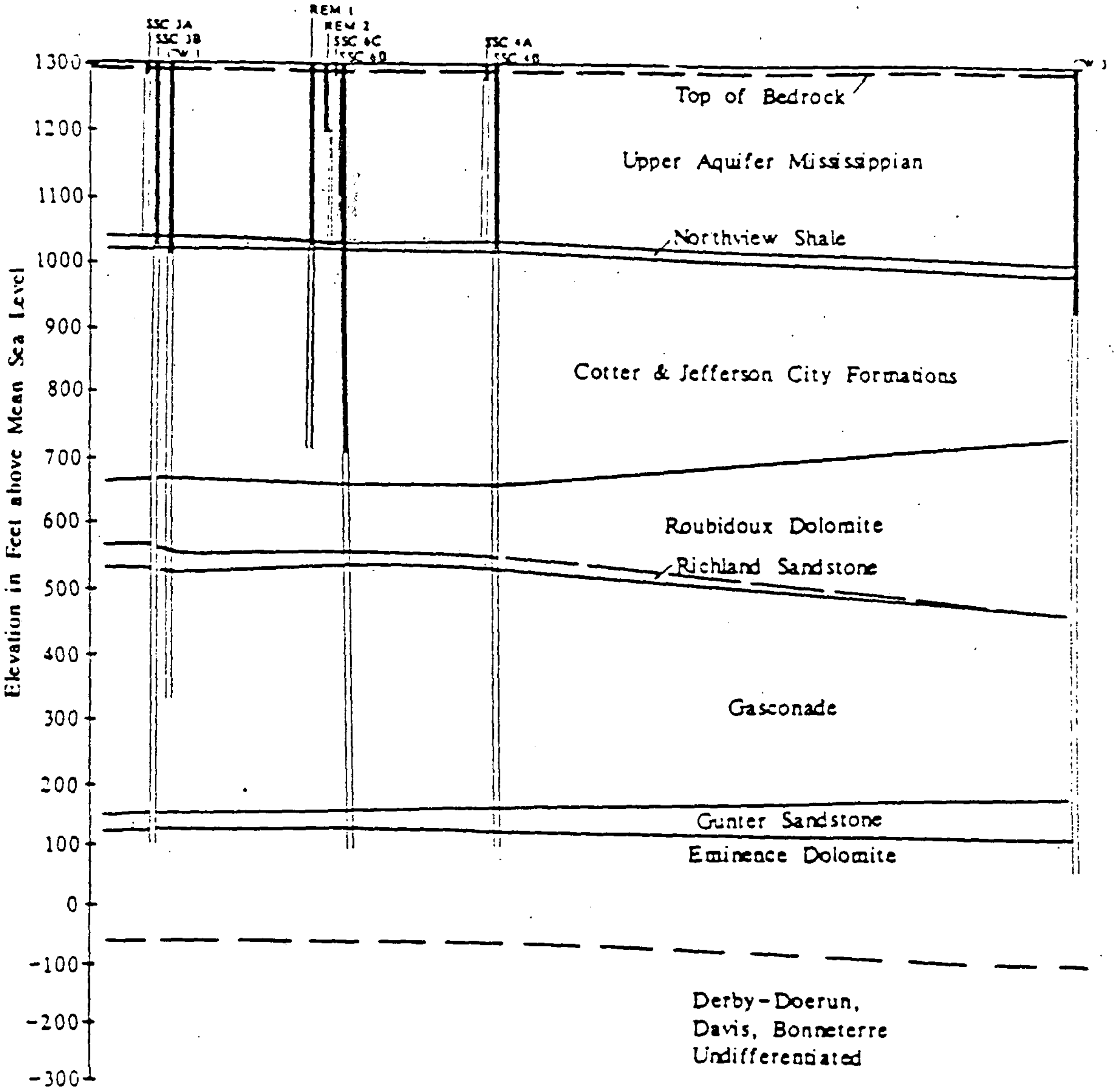
Tables and diagrams presented in this section are either derived in part or entirely duplicated from the RI report written by Geraghty & Miller, Inc. for Solid States Circuits, Inc. Trichloroethene (TCE), a VOC, was the most common contaminant detected in all media types; other contaminants were detected at much lower frequencies and concentrations. For this reason, diagrams will be based on TCE concentrations.

5.1 <u>HYDROGEOLOGIC SETTING</u>

A sequence of three hydrologic units is known to exist beneath and near the site: 1) the unconsolidated/fractured bedrock system (UFSB), 2) the unfractured shallow bedrock system (SBR), and 3) the deep bedrock system (DBR). Figure 4 pictorially presents the site and local hydrogeology.

Republic lies within the Springfield-Salem Plateau sections of the Ozark Plateaus physiographic province, interior Highlands Division. Rocks of Mississippian Age underlie most of the region. The Mississippian Formations are generally coarse crystalline limestone which contain discontinuous beds of chert.

The upper portion of these formations has been intensely weathered, resulting in an overlying residuum layer of silt, clay, and chert fragments. The UFSB unit is this overlying layer and is shown on Figure 4 as the thin layer above bedrock. This unit is approximately twenty feet thick. The UFSB is not important as a regional aquifer.



BEDROCK GEOLOGIC CROSS SECTION K-L

| Casing

|| Open Borehole

FIGURE 4

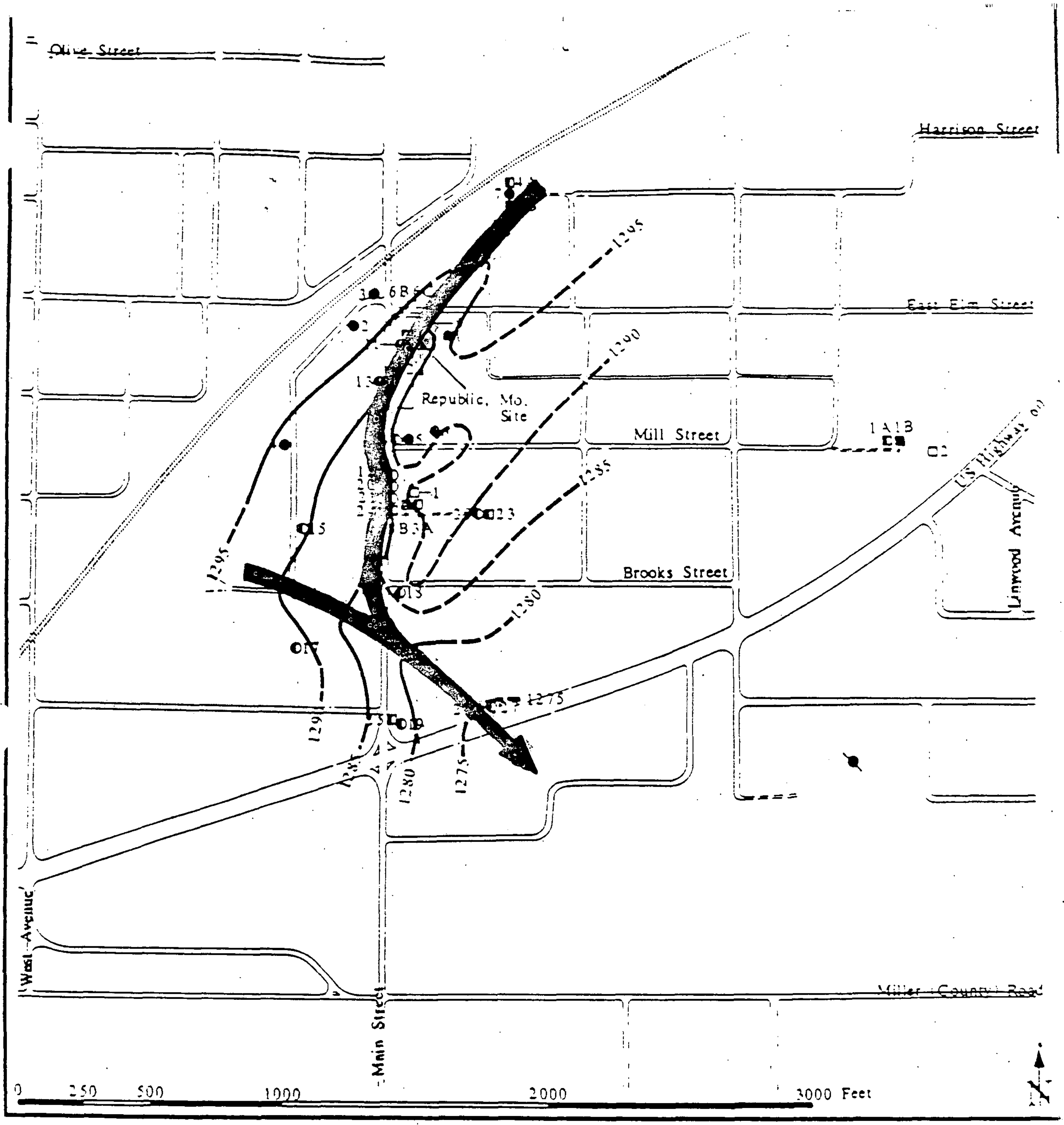
Ground water flow in the UFSB is in the same general direction as surface water runoff or flow, unless influenced by other local features such as fracturing. Two fractured bedrock lows in the upper part of the shallow bedrock were identified during the RI. One originates northeast of the site and runs beneath the site as it swings in a broad arc crossing Main Street south of the site, recrossing Main Street, and then trends south-southeast toward U.S. Highway 60. The second narrow bedrock surface low trends east-southeast towards Main Street and intersects the other low near U.S. Highway 60. The saturated thickness of the UFSB decreases from approximately 15 feet at the site to less than a foot near U.S. Highway 60. This pattern reflects that a strong fracture is acting as a ground water sink. Figure 5 shows the locations and trends of the narrow bedrock lows.

The SBR unit is the minor aquifer consisting primarily of deeply weathered, cherty limestone and residuum overlying the Northview Formation. On Figure 3, the SBR unit extends approximately 270 feet from the UFSB to the Northview Shale formation. The SBR and perhaps deeper bedrock units regionally can have fractures or joints which can significantly impact the flow of ground water and transport of contaminants. In regions where weathering has reached a high degree of maturity, the area is termed a "karst" region characterized by sinkholes, caves, springs, and losing streams. Based on information gained during construction of the bedrock monitoring wells, the SBR exhibited an unfractured and unweathered physical character, indicating a limited potential for the existence of fractures locally.

Ground water flows in a southeasterly direction during static conditions in the SBR. Pumping of Municipal Well No. 1 effectively contains the ground water around the site.

The top of the Northview Formation is approximately 290 feet below the ground surface at the site. The Northview Formation is a confining layer composed of siltstone and shale and having an estimated vertical permeability of 0.000000001 (1×10^{-9}) to 0.000001 (1×10^{-6}) feet per second. This Northview shale acts as a confining bed restricting flow between the SBR and DBR.

The DBR unit is the major aquifer in the area and the one used for the City of Republic's drinking water source. Large quantities of ground water are withdrawn from the major aquifer by wells in and around Springfield. The DBR unit is confined beneath the Northview Formation and consists of a dolomite sequence, primarily the Jefferson City-Cotter Formations. A major portion of recharge to the DBR comes from water leaking downward through the overlying material, or from recharge directly from infiltration where it is exposed to the land surface. The closest outcrop to the site is about four miles east. Ground water elevations in the major aquifer are from 100 to 300 feet lower in elevation than ground water elevations in



BEDROCK SURFACE CONTOUR MAP

Contour Interval = 5'

1280.7 = Bedrock Elevation in Feet above Mean Sea Level

- SSC-_ Shallow Bedrock Monitoring Well
- SSC-_ Deep Bedrock Monitoring Well
- REM-_ Recovery Well
- CW-_ Municipal Well
- SSC-_ Shallow Unconsolidated Monitoring Well (RI)
- MW-_ Shallow Unconsolidated Monitoring Well (Pre-RI)
- Cave Well

FIGURE 5

the minor aquifer due to ground water pumpage in the major aquifer. Increased drawdown in the DBR has the potential of increasing the recharge through the overlying material. Contaminants entering the shallow aquifer can potentially migrate to the DBR either by natural leakage through the Northview Formation, or by seepage into and down improperly constructed water wells, or along fractures or faults that penetrate this confining formation.

Ground water flow in the DBR within Republic is controlled by the city's well system. With Municipal Well Number 1 off, ground water from the site flows toward Municipal Well Number 2. Pumping Municipal Well Number 1 effectively contains ground water in and around the site.

5.2 Source Characteristics

The response actions undertaken by MDNR/SSC and EPA removed any immediate sources in the form of contaminated soils from the basement area. This is confirmed by analyses of RI data which indicate that TCE concentrations in ground water are greater than TCE concentrations found in onsite, subsurface soils. Ground water is the current source of contamination detected in the soils, as explained in the following Soils and Ground Water subsections.

5.3 Surface Water

The RI surface water investigation concluded that Roberts Spring and Shuyler Creek were the most likely bodies of surface water to be impacted by the site. Since Shuyler Creek is dry most of the year, Roberts Spring was sampled. No contaminants related to the site were found in the surface water samples collected at Roberts Spring.

5.4 Soils

Table 1 presents a list of contaminants found in surface or subsurface soils and presents the frequency of occurrence, maximum and average concentrations, and location of maximum concentration for each contaminant identified.

Onsite surface soils contain VOCs at relatively low concentrations. The relatively high concentrations shown in Table 1 for benzene, 1,1-dichloroethene and methylene chloride are not true soil concentrations. Instead, these concentrations were obtained from samples of the air (or headspace) above the soil inside the soil sample jar. Actually, these results are a better indication of soil gas concentrations. Given the high concentrations of VOCs known in shallow ground water, the soil gas concentrations were not unexpected.

TABLE 1. SUMMARY OF CHEMICAL CONSTITUENTS DETECTED IN SOIL SAMPLES

CONSTITUENT	NO. DETECTED/ NO. ANALYZED	MAXIMUM/AVERAGE(1) CONCENTRATION (UG/KG)	MAXIMUM CONCENTRATION LOCATION
BENZENE	9/88	460/ (2) 55	ONSITE SURFACE
CHLOROFORM	7/80	11/ 5.3	OFFSITE SUBSURFACE
1,1-DICHLOROETHANE	3/80	20/ 13	ONSITE SUBSURFACE
1,1-DICHLOROETHENE	9/88	11,000/ (2) 3,607	ONSITE SURFACE
ETHYLBENZENE	1/80	2.6/ 2.6	OFFSITE SURFACE
METHYLENE CHLORIDE	9/88	2,700/ (2) 319	ONSITE SURFACE
TETRACHLOROETHENE	5/88	69/ 40.2	ONSITE SURFACE
TOLUENE	8/80	7.8/ 5.2	OFFSITE SURFACE
TRANS-1,2-DICHLOROETHENE	5/72	180/ 42.4	ONSITE SUBSURFACE
1,1,1-TRICHLOROETHANE	10/80	110/ 27.1	ONSITE SUBSURFACE
1,1,2-TRICHLOROTHANE	3/80	5.7/ 4.4	ONSITE SUBSURFACE
TRICHLOROETHENE	30/80	4,200/ 313	ONSITE SUBSURFACE
VINYL CHLORIDE	3/80	3.7/ 3.3	ONSITE SUBSURFACE

(1) AVERAGE CONCENTRATION IS CALCULATED USING ONLY SAMPLES IN WHICH THE CONSTITUENT IS DETECTED. FOR EXAMPLE, ETHYLBENZENE WAS FOUND IN ONLY ONE OF EIGHTY SAMPLES, HOWEVER THE AVERAGE CONCENTRATION IS BASED ON THAT ONE POSITIVE RESULT.

(2) COMPOUND QUALITATIVELY IDENTIFIED BY PORTABLE GC; SAMPLE TAKEN FROM HEADSPACE IN SAMPLE JAR.

Onsite VOC concentrations are less than 150 micrograms per kilogram (ug/kg, or commonly referred to as parts per billion - ppb) to a depth of five to twelve feet below land surface. VOC concentrations increase with depth with the greatest concentrations near the bedrock surface approximately twenty-five feet below the ground surface. The highest onsite subsurface soil TCE concentrations, up to 4,200 ug/kg, are found in the southern part of the former basement area and in the five to ten feet above the top of bedrock. As it will be shown, VOCs in the ground water are at least five times higher than the concentrations reported in the soil, indicating that the VOCs in the ground water are the source for the VOCs in the soil. Earlier removal actions by MDNR/SSC and EPA had eliminated the most contaminated, onsite surface and subsurface soils as a source for the continued release of VOCs.

RI activities identified very low levels of VOCs in offsite surface soils. In fact, the detected concentrations barely exceed analytical detection levels and are not a concern at these concentrations. Offsite subsurface soil contamination is limited to the fracture zone along Main Street. The maximum reported TCE concentrations in offsite subsurface soil along Main Street was 340 ug/kg from a depth of 11 to 17.5 feet below land surface. The maximum TCE concentration identified in offsite, subsurface soils away from Main Street is 24 ug/kg.

Soil samples were analyzed for VOCs only and not for other organic or metal contaminants. Since VOCs are very mobile, VOCs analysis was used to indicate the extent of soil contamination.

5.5 <u>GROUND WATER</u>

As described earlier, a sequence of three hydrologic units is known to exist beneath and near the site: 1) the unconsolidated/fractured bedrock system (UFSB), 2) the unfractured shallow bedrock system (SBR), and 3) the deep bedrock system (DBR). Table 2 presents a summary of the frequency of occurrence, maximum and average concentrations, and location of maximum concentration for each contaminant detected in ground water.

5.6 <u>UFSB UNIT</u>

The UFSB is composed of two units: unconsolidated residual soils and the upper portion of the bedrock that exhibits a high degree of weathering or fracturing. The vertical fracturing appears to be limited to depths of less than 100 feet in the upper bedrock.

TABLE 2. SUMMARY OF CHEMICAL CONSTITUENTS DETECTED IN GROUND WATER

CONSTITUENT	NO. DETECTED/ NO. ANALYZED	MAXIMUM/AVERAGE(1) CONCENTRATION (UG/L)	MAXIMUM CONCENTRATION LOCATION
METALS			
CADMIUM	1/35	21/ 21	ONSITE SBR
CHROMIUM	1/35	190/ 190	ONSITE SBR
COPPER	15/54	55/ 19.3	REPUBLIC DRINKING WATER
IRON	39/91	47,700/ 5,300	ONSITE UFSB
LEAD	2/35	7/ 7	OFFSITE UFSB
MAGNESIUM	91/91	34,000/ 13,200	OFFSITE UFSB
MANGANESE	22/48	32,900/ 5,230	OFFSITE UFSB
MERCURY	9/35	0.2/ 0.2	ONSITE DBR
NICKEL	3/35	80/ 70	ONSITE SBR
ZINC	18/33	3,770/ 491	ONSITE SBR

(1) AVERAGE CONCENTRATION IS CALCULATED USING ONLY SAMPLES IN WHICH THE CONSTITUENT IS DETECTED. FOR EXAMPLE, CADMIUM WAS FOUND IN ONLY ONE OF THIRTY-FIVE SAMPLES, HOWEVER THE AVERAGE CONCENTRATION IS BASED ON THAT ONE POSITIVE RESULT.

TABLE 2. SUMMARY OF CHEMICAL CONSTITUENTS DETECTED IN GROUND WATER

CONSTITUENT	NO. DETECTED/ NO. ANALYZED	MAXIMUM/AVERAGE(1) CONCENTRATION (UG/L)	MAXIMUM CONCENTRATION LOCATION
VOLATILE ORGANICS			
ACROLEIN	1/97	43/ 43	REPUBLIC DRINKING WATER
BENZENE	6/201	4.8/ 2.9	ONSITE SBR
CARBON TETRACHLORIDE	1/201	32/ 32	ONSITE DBR
CHLOROBENZENE	6/202	11/ 5.7	ONSITE SBR
CHLOROETHANE	1/191	6.3/ 6.3	ONSITE SBR
CHLOROFORM	7/202	12/ 6.2	ONSITE SBR
1,1-DICHLOROETHANE	48/202	890/ 95.3	ONSITE SBR
1,2-DICHLOROETHANE	4/202	44/ 13.7	OFFSITE UFSB
1,1-DICHLOROETHENE	43/203	1000/ 114.2	ONSITE SBR
1,2-DICHLOROPROPANE	1/201	4/ 4	OFFSITE UFSB
1,3-DICHLOROPROPYLENE	1/99	7.1/ 7.1	ONSITE SBR
ETHYLBENZENE	6/201	16/ 7.3	ONSITE SBR

(1) AVERAGE CONCENTRATION IS CALCULATED USING ONLY SAMPLES IN WHICH THE CONSTITUENT IS DETECTED. FOR EXAMPLE, ACROLEIN WAS FOUND IN ONLY ONE OF NINETY-SEVEN SAMPLES, HOWEVER THE AVERAGE CONCENTRATION IS BASED ON THAT ONE POSITIVE RESULT.

TABLE 2. SUMMARY OF CHEMICAL CONSTITUENTS DETECTED IN GROUND WATER

CONSTITUENT	NO. DETECTED/ NO. ANALYZED	MAXIMUM/AVERAGE(1) CONCENTRATION (UG/L)	MAXIMUM CONCENTRATION LOCATION
VOLATILE ORGANICS			
METHYL CHLORIDE	2/191	27/ 15/1	OFFSITE UFSB
METHYLENE CHLORIDE	36/203	4300/ 466.1	ONSITE SBR
TETRACHLOROETHENE	11/203	180/ 44.9	ONSITE SBR
TOLUENE	26/203	1500/ 221.7	ONSITE SBR
TRANS-1,2-DICHLOROETHENE	15/147	3100/ 343.5	ONSITE SBR
1,1,1-TRICHLOROETHANE	43/203	14,000/ 1123.1	ONSITE SBR
1,1,2-TRICHLOROETHANE	8/202	[illegible]/ 35.5	ONSITE SBR
TRICHLOROETHENE	137/201	290,000/ 11,623	ONSITE SBR
VINYL CHLORIDE	27/192	410/ 27.1	ONSITE UFSB
ACETONE	1/22	81/ 81	ONSITE DBR
2-BUTANONE	1/20	25/ 25	OFFSITE UFSB
CARBON DISULFIDE	1/20	12/ 12	OFFSITE UFSB
1,2-DICHLOROETHYLENE	7/55	210/ 104.4	ONSITE DBR

(1) AVERAGE CONCENTRATION IS CALCULATED USING ONLY SAMPLES IN WHICH THE CONSTITUENT IS DETECTED. FOR EXAMPLE, ACETONE WAS FOUND IN ONLY ONE OF TWENTY SAMPLES, HOWEVER THE AVERAGE CONCENTRATION IS BASED ON THAT ONE POSITIVE RESULT.

The TCE plume is defined as shown in Figure 6. Ground water flow in the UFSB near the site is controlled by a fracture zone defined along Main Street (Figure 5). The VOC contamination is restricted to a narrow area, less than 50 feet wide and greater than 10 feet below land surface, south of the site along Main Street. The highest concentrations occur at the top of bedrock and/or in the fracture zone. Concentrations decrease with depth in the bedrock below the fracture zone.

Outside of the fracture zone, VOC concentrations decrease dramatically and the depth to water increases significantly, indicating that flow and contaminant transport is along the fracture and downward into the bedrock. South of Highway 60, the specific location of the fracture is not well defined. The extent of contaminants should also be restricted to a zone surrounding the fracture at a depth of greater than 10 to 15 feet below land surface. The direction of ground water flow and contaminant transport should be in a south-southeast direction toward Shuyler Creek.

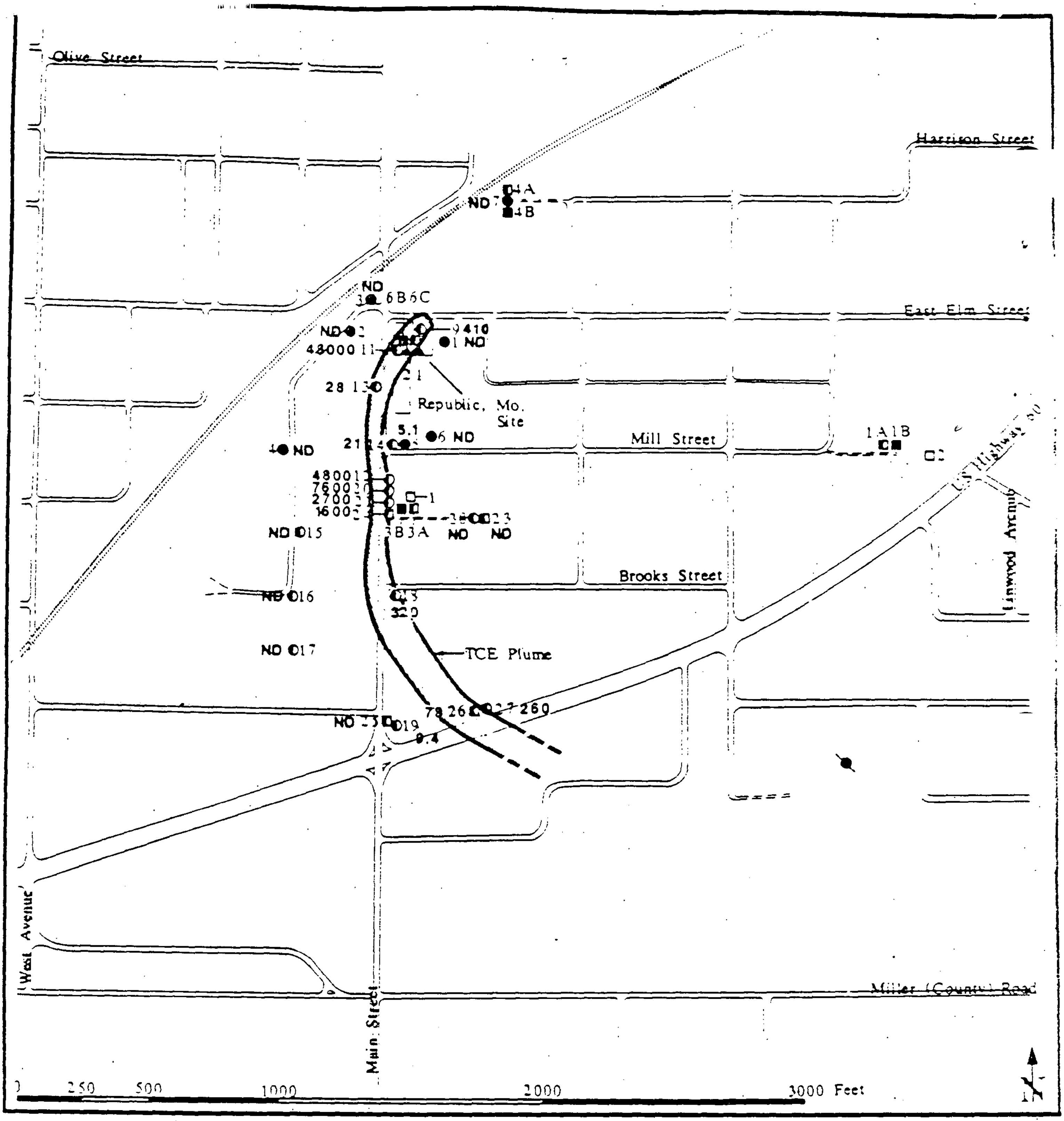
In the UFSB, the TCE concentrations in ground water range from less than 300 ug/l (ppb) near Highway 60 to 40,000 ug/l onsite. Municipal Well Number 1 is the approximate midway point between the site and Highway 60. At Municipal Well No. 1, the TCE concentration in ground water ranges from 2,000 ug/l to 7,000 ug/l.

Except for zinc, offsite and onsite UFSB inorganic water quality is representative of background conditions. Zinc was detected in one offsite well and two onsite wells with a maximum concentration of 90 ug/l. No instances of inorganic constituents attributable to the site exceed Federal or Missouri drinking water and Missouri water quality standards.

Several volatile organic constituents were detected in concentrations exceeding Federal or Missouri drinking water and Missouri water quality standards. Appendix A presents a list of the pertinent Federal and Missouri drinking and Missouri water quality standards. For example, the Federal and Missouri drinking water standard for TCE is 5 ug/l.

The estimated probable pumping rate for the UFSB ranges from 6 to less than 15 gallons per minute. There is estimated to be over 15 million gallons of contaminated water.

The pathway along which contaminants have migrated is clear and can be defined based on TCE concentrations, ground water flow directions, and top of bedrock elevations. The chemicals have migrated approximately 1500 feet south of the site. The ultimate discharge point for the UFSB appears to be the system of caves below Shuyler Creek.



GROUND-WATER TCE CONCENTRATIONS, UNCONSOLID. FRACTURED SHALLOW BEDROCK SYSTEM (UFSB)

ND Not Detected Above Method Detection Limit
◘ SSC-_Shallow Bedrock Monitoring Well
■ SSC-_Deep Bedrock Monitoring Well
▲ REM-_Recovery Well
◻ CW-_Municipal Well

The TCE Concentration Shown is the Maximum Reported Value for All Sampling Events
◐ SSC-_Shallow Unconsolidated Monitoring Well-(RI)
● MW-_Shallow Unconsolidated Monitoring Well (Pre-RI)
Cave Well

FIGURE 6

5.7 SBR UNIT

The SBR system consists of the bedrock units away from Main Street, between the top of the unweathered bedrock to the top of the Northview shale, generally between depths of 20 to 300 feet below land surface. Figure 7 illustrates the horizontal distribution of the TCE plume as defined by the RI sampling of the SBR wells. The Main Street fracture zone also impacts the distribution of VOCs in the SBR as shown in Figure 7. Offsite SBR TCE concentrations decrease with depth in the bedrock below and away from the fracture zone. TCE was detected at concentrations greater than 170 ug/l in well SSC-3A, the only SBR well along Main Street and located less than 20 feet from the defined fracture. It is believed that the TCE in SSC-3A is related to contaminants that have migrated along the Main Street fracture.

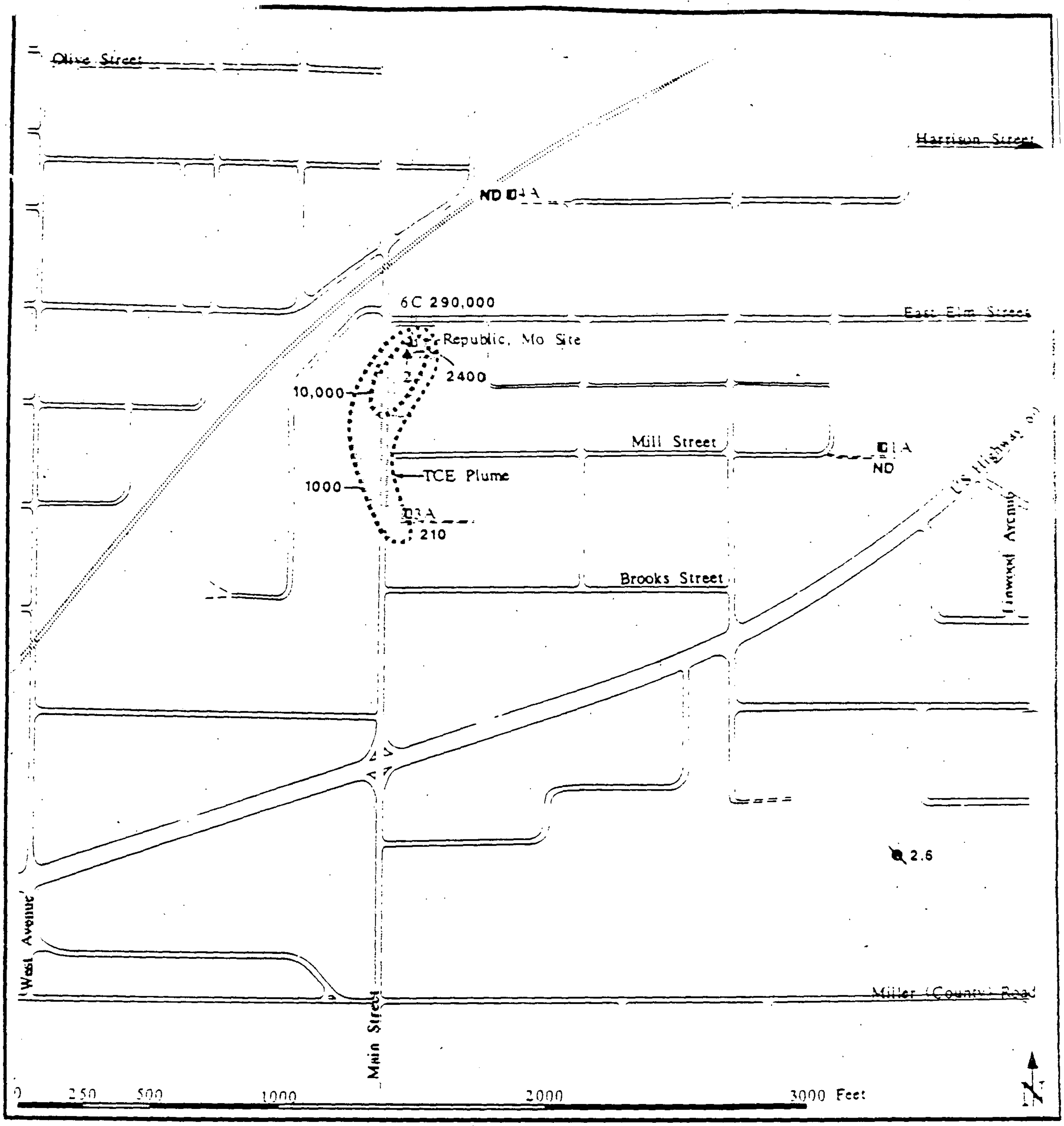
Onsite, the maximum TCE concentration reported was 290,000 ug/l. In general, the highest reported VOC concentrations occur onsite in the SBR between 150 and 300 feet below land surface.

Cadmium, chromium, copper, lead, mercury, nickel and zinc were reported above detection levels in onsite SBR wells. Zinc was reported above detection levels in six of six samples and nickel in three of six samples. All other metals were reported above detection levels only once in six samples. Chromium was detected in one sample at a concentration above the Federal and Missouri drinking water standards. The single occurrence of chromium was the only value for chromium reported above a detection level during RI sampling activities. No metals were detected above the detection level from any offsite SBR wells along Main Street.

Although Cave Well is a karst feature, it is not believed to have a direct hydrologic connection to the Main Street fracture and was sampled as part of the SBR system. A TCE concentration of 2.6 ug/l was reported in one sample collected from Cave Well, while a previous sample reported TCE below the detection limit of 2.0 ug/l. Zinc and mercury were detected in Cave Well at 0.02 ug/l and 0.0001 ug/l, respectively.

Documented hydrogeologic parameters for the shallow bedrock indicate a limited potential for the movement of contaminants. In the SBR, the average ground water velocity is 0.0009 feet/day or 3.35 feet per year. It is estimated that from 1968 to the present, the contaminants in the SBR have migrated less than 100 feet from the point of release. Thus, the VOCs have not been able to to migrate from the site and disperse. This accounts for the high VOC concentrations reported from the onsite monitoring wells.

The ultimate discharge point for the SBR is the James River or Wilson Creek valleys.



GROUND-WATER TCE CONCENTRATIONS, UNFRACTURED SHALLOW BEDROCK SYSTEM (SBR)

ND Not Detected Above Method Detection Limit
Cave Well
SSC-_Shallow Bedrock Monitoring Well
▲ REM-_Recovery Well

The TCE Concentration Shown is the Maximum Reported for All Sampling Events
Concentrations in ug/L

FIGURE 7

5.8 DBR UNIT

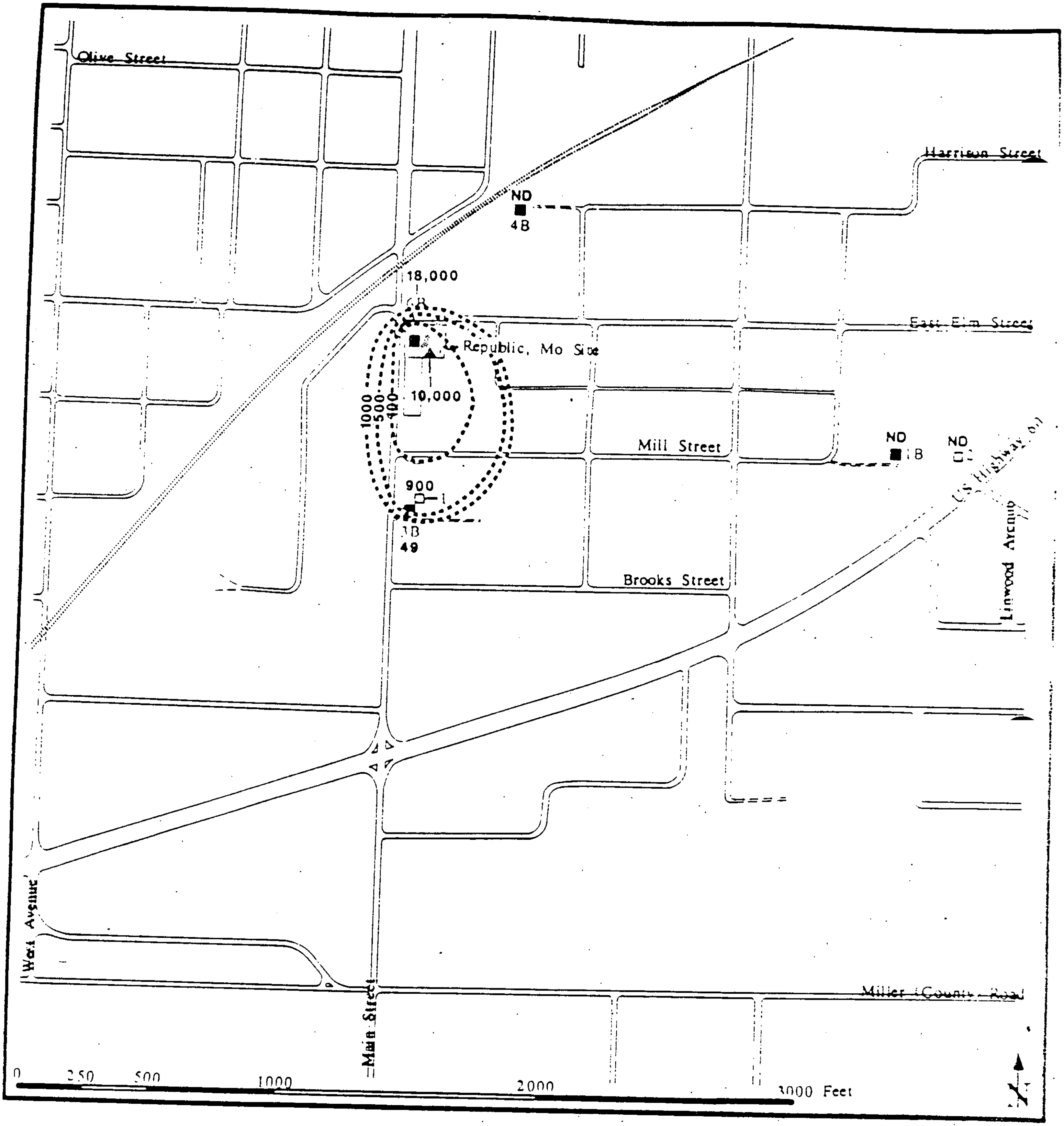
The DBR consists of the bedrock units from approximately 300 feet to greater than 1200 feet in depth. Figure 8 illustrates the horizontal distribution of TCE in the deep bedrock. The only deep bedrock samples that showed VOC contamination were limited to onsite wells and the wells near Municipal Well Number 1.

At the site, the contaminants have migrated no further than 700 feet deep vertically, with the greater chemical concentrations occurring between 150 to 300 feet in depth. At Municipal Well Number 1, the contaminants extend vertically to a depth of 1,000 feet, with the greater chemical concentrations occurring between 400 to 500 feet in depth.

The pump intake for Municipal Well Number 1 was set at approximately 450 feet. Chemical data and hydrogeologic data show that pumpage of Municipal Well Number 1 and an existing regional upward hydraulic gradient control the vertical and horizontal migration of the plume. Stopping the pumping of Municipal Well Number 1 allows Municipal Well Number 1 to act as an open conduit for contaminants to migrate to depths below 700 feet. The location of Municipal Well Number 1 approximately represents the southern end of the plume. To date, no VOCs have been detected in Municipal Wells 2, 3, and 4. Although the eastern and western boundaries of the plume have not been pinpointed, they are believed to extend less than 800 feet away from the site, based on ground water modelling.

In the DBR, the transport of contaminants is toward the pumping wells. Municipal Well Number 1 controlled flow from the site until the well was shut down. Municipal Well Number 1 was restarted; however, during the shutdown, flow from the site was toward Municipal Well Number 2. The calculated ground water velocity is 0.43 feet/day or 157 feet/year. The maximum probable distance contaminants could have migrated away from the site toward Municipal Well Number 2 since 1983 is 785 feet, approximately one-third the total distance of 2,100 feet. In the absence of onsite pumpage, it would take approximately 13 years for the leading edge of the plume to reach Municipal Well Number 2. However, Municipal Well Number 1 is currently pumping with the water discharging into the sewer, so it is controlling the flow of contamination from the site.

The inorganic characteristics of water in the DBR system is parallel to that of water from the SBR. Copper was reported above the detection level in fourteen samples collected from offsite DBR wells away from Main Street. The only samples that have copper values above detection levels are from Municipal Wells. Lead, mercury, and zinc were detected in onsite DBR wells at concentrations of 0.007 ug/l, 0.0002 ug/l, and 0.44 ug/l,



GROUND-WATER TCE CONCENTRATIONS, DEEP BEDROCK SYSTEM (DBR)

ND Not Detected Above Method Detection Limit
••• TCE Concentration Contour
□ CW-_Municipal Well
▲ REM-_Recovery Well
■ SSC-_Deep Bedrock Monitoring Well

The TCE Concentration Shown is the Maximum Reported Value for All Sampling Events
Concentrations in ug/L

FIGURE 8

respectively. Mercury (0.002 ug/l) and zinc (0.02 ug/l) were detected in offsite DBR wells along Main Street. These values are not above Federal or Missouri drinking water standards.

In onsite and offsite DBR wells, TCE again was the most frequently detected constituent and TCE was detected at the highest concentrations. The maximum offsite TCE concentration was 900 ug/l in Municipal Well Number 1. The maximum TCE concentration onsite was 18,000 ug/l. Many volatile organic compounds were detected onsite and offsite at levels above Federal or Missouri drinking water standards.

5.9 UTILITIES

The utility lines are at depths below the water surface of the UFSB north of Brooks Street. Ground water containing VOCs may enter the utility lines north of Brooks Street and be carried south of Brooks Street by flow within the utility. Water in buried utilities and the Publicly Owned Treatment Works (POTW) was sampled and analyzed for contaminants during the RI. Table 3 presents a summary of frequency of occurrence, maximum and average concentrations, and the location of maximum concentration for each constituent detected. Figures 9 and 10 illustrate the TCE concentration trends for the sewer and telephone manholes, respectively. A discussion of sewer and telephone air contamination is contained elsewhere in the Summary of Site Risks.

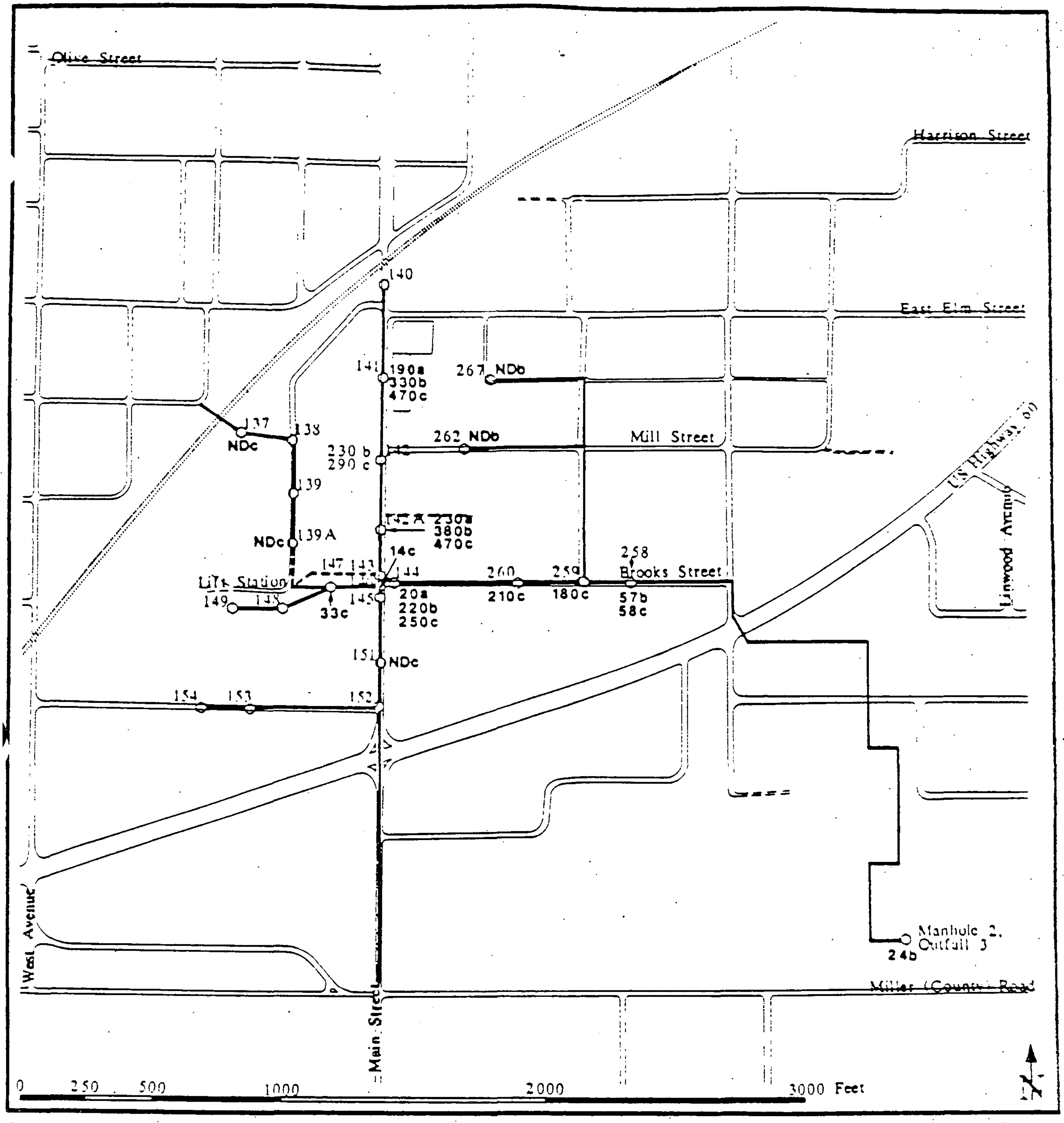
The highest VOC concentrations were detected in the Republic sewer system and the Southwestern Bell manholes along Main Street directly south of the site. Maximum and average concentrations of detected chemical constituents decreased along the flow path. No contaminants were found at detectable levels in the Republic sewer system directly east of the site. Concentrations detected in Southwestern Bell manholes decreased sharply away from the site, to concentrations close to the method detection limit. Trichloroethene was not detected in the Southwestern Bell system north of the site or south of U.S. Highway 60.

During the RI, SSC installed two air strippers in series to evaluate their effectiveness in removing site contaminants from ground water, and to pretreat ground water prior to discharge to the sewer during certain RI activities which generated large volumes of contaminated ground water. This work was referred to as the Pilot Study. Currently, these air strippers remain at the site, but are not in operation. SSC had entered into an agreement with the City of Republic to allow disposal of treated ground water into the City of Republic sewer system and POTW. Pretreatment standards for site discharge limited the flow to 200 gallons per minute and 200 ug/l TCE. Samples were taken every two weeks from the air stripper effluent to the sewer and at the POTW influent and effluent. The discharge from the air stripper into the sewer system did not exceed the pretreatment standards. Specifically, the discharge from the air stripper system never exceed 26 UG/L OF tce.

TABLE 3. SUMMARY OF CHEMICAL CONSTITUENTS DETECTED IN WATER IN UTILITIES

CONSTITUENT	NO. DETECTED/ NO. ANALYZED	MAXIMUM/AVERAGE(1) CONCENTRATION (UG/L)	MAXIMUM CONCENTRATION LOCATION
CHLOROFORM	6/50	160/ 55	SEWER
1,1-DICHLOROETHANE	2/50	4.9/ 4.2	SW BELL
1,1-DICHLOROETHENE	1/50	2.7/ 2.7	SEWER
1,3-DICHLOROPROPYLENE	1/26	5.2/ 5.2	SW BELL
ETHYLBENZENE	2/50	3.9/ 2.6	SEWER
METHYLENE CHLORIDE	3/50	120/ 49.3	SW BELL
TOLUENE	2/50	2.3/ 2.3	SEWER
TRANS-1,2-DICHLOROETHENE	8/49	310/ 114.8	SEWER
1,1,1-TRICHLOROETHANE	10/50	28/ 7.9	SEWER
TRICHLOROETHENE	32/50	470/ 147.3	SEWER

(1) AVERAGE CONCENTRATION IS CALCULATED USING ONLY SAMPLES IN WHICH THE CONSTITUENT IS DETECTED.

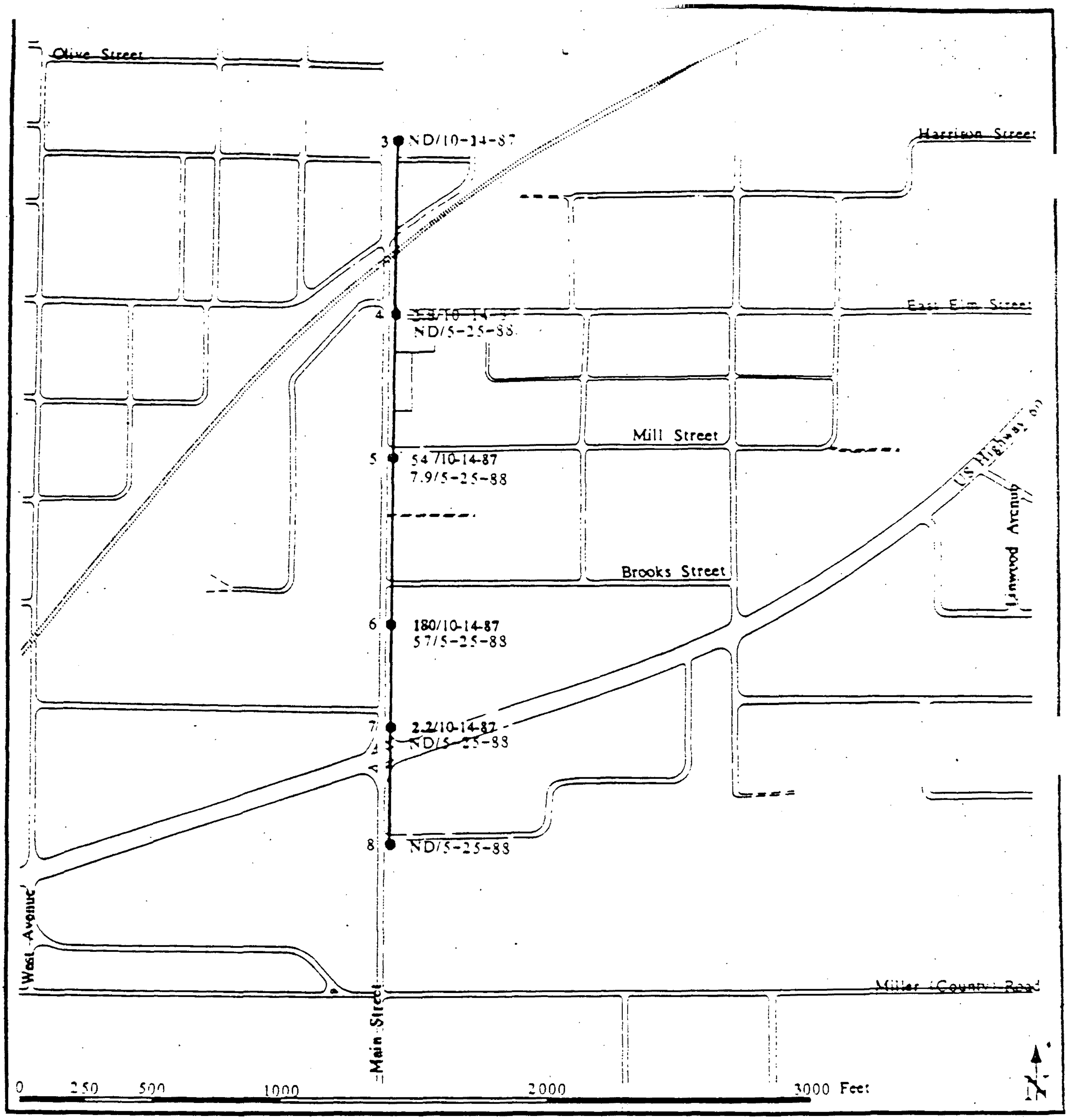


WATER TCE CONCENTRATIONS FROM SANITARY SEWER SYSTEM

Concentration in ug/l
ND Not Detected at 2.0 ug/l Detection Limit
○ Sewer Manhole
- - - Forced Main
—— Gravity Line

a Sampled June 11, 1987
b Sampled July, 1987
c Sampled May, 1988

FIGURE 9



TCE CONCENTRATIONS DETECTED IN SOUTHWESTERN BELL MANHOLES

—— Southwestern Bell Buried Line
4 ● Southwestern Bell Manhole and Numbers
5.4/10-14-87 TCE Concentration/Sample Date

FIGURE 10

The NPDES permit for the POTW does not allow the POTW effluent to exceed 2 ug/l. Discharge from the Republic site did not cause the POTW to exceed the NPDES requirements. Average TCE levels in the influent and effluent streams for the POTW did not change during the air stripper pilot study. One excursion did occur but it could not be attributed to site operations.

5.10 AIR

Air sampling was conducted during the RI field activities to document the following: the health and safety of onsite workers; and, offsite emissions at the POTW, in the sewer and Southwestern Bell utility manholes, in the basement of the building adjacent to the site, and in the basement of the residential homes near the UFSB fracture zone.

Occupational Safety and Health Association (OSHA) threshold limit values (TLVs) were not exceeded in the normal breathing zone of an onsite worker, i.e., approximately 4 to 6 feet from the source. Total VOCs were above the OSHA TLV during onsite well construction, with the monitoring instrument held close to the source. This is not considered the breathing zone.

Offsite at the POTW, an air sample taken downgradient from the POTW aeration pond was measured at a concentration of 45 ug/l of 1,1,1-trichloroethane which is below the OSHA TLV; at the POTW aeration pond, methylene chloride was found at 5000 ug/l which is above the OSHA TLV. Neither of these samples are considered attributable to the site discharge for several reasons: a) the air concentrations are far above any level which could be achieved by air dispersion of the VOCs in the site discharge from the POTW's brush aerator; b) methylene chloride was not detected in ground water at concentrations which could produce the air concentration; and, c) POTW chlorination units produce these types of compounds.

The maximum concentrations detected in the sewer manholes occurred at manhole No. 144 (refer to Figure 8) during the February 1988 sampling event. The maximum concentrations were benzene at 290 ug/l, methylene chloride at 11,000 ug/l, tetrachloroethene at 720 ug/l, and TCE at 770 ug/l. Each of these concentrations exceed the OSHA TLV for each contaminant. However, a second sampling event several months later did not detect any of these contaminants above detection limits.

The maximum concentrations detected in Southwestern Bell manholes occurred at manhole No. 5 (refer to Figure 9) with benzene at 29 ug/l, tetrachloroethene at 530 ug/l, and TCE at 280 ug/l. Of these concentrations, benzene is very close to the OSHA TLV for benzene and TCE exceeds the OSHA TLV. The Southwestern Bell concentrations were obtained when the manhole was filled with water. Southwestern Bell standard operating procedure includes pumping out the water and purging with fresh air before and during manhole work. A second sample was taken several months later; this sample was obtained after pumping the water out of the manhole. Only TCE was detected and at a much lower concentration, 3 ug/l.

In a sample taken from the basement of the building adjacent to the site during the June 1988 sampling event, benzene was detected at 2.0 ug/l, methylene chloride at 5,400 ug/l, tetrachloroethene at 1,100 ug/l, and TCE at 330 ug/l. This building is unoccupied. Analysis of basement air samples taken from residences near the UFSB fracture zone did not reveal contamination attributable to the site.

Currently, the site is covered with 1 to 2 feet of clean gravel to inhibit plant growth, so fugitive dust emissions should not be a problem.

SECTION 6.0 SUMMARY OF SITE RISKS

As part of the RI/FS process, a risk assessment was conducted in order to assess the current and potential risks to human health and to the environment due to the site. This risk assessment provides a baseline risk assessment to assist in the development of remedial alternatives. This section summarizes the findings concerning the quantified risks. Future conditions were evaluated such as new drinking wells installed onsite and offsite. In addition, the risk assessment also evaluated risks associated with certain remedial actions considered potentially applicable to the site: i.e., air stripping of contaminated ground water. The risk assessment provides valuable information used to determine the need for cleanup action(s).

6.1 IDENTIFICATION OF CONTAMINANTS OF CONCERN

As presented in the previous section, Summary of Site Characteristics, and summarized in Appendix B, thirty-three contaminants were identified in various media. Due to the wide variations in occurrence, concentrations, and toxicities between contaminants, a selection process was implemented to identify indicator chemicals for evaluation in the risk assessment. Indicator chemicals are selected to focus the assessment on the chemicals that represent the most probable risk to the public and the environment. This process resulted in the selection of seven indicator chemicals which are presented in Table 4. Table 4 also lists the highest concentration detected and pertinent regulation(s) for each indicator chemical in each media, except air.

TABLE 4

APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENTS OR HEALTH GUIDELINES FOR INDICATOR CHEMICALS DETECTED AT THE REPUBLIC, MISSOURI SITE

Chemical	GROUND-WATER: Maximum Reported Concentration (mg/L)	GROUND-WATER: MCL[1]	GROUND-WATER: State of Missouri[5] Ground Water (VI, VII)	SURFACE WATER /POTW EFFLUENT: Maximum Reported Concentration (mg/L)	SURFACE WATER /POTW EFFLUENT: Aquatic Life[2]	SURFACE WATER /POTW EFFLUENT: State of Missouri Protection of Aquatic Life (I)	SURFACE WATER /POTW EFFLUENT: Fish Ingestion[3]	SOILS: Maximum Reported Concentration (mg/kg)	SOILS: Health Guideline
1,1-Dichloroethane	.890	NS	.00094	ND	NS	NS	NS	.450	NS[6]
1,1-Dichloroethene	1.0	.007	.007	ND	11.6	NS	0.0018	.086	NS[6]
1,2-Dichloroethene(Trans)	.880	.007[4]	NS	ND	11.6	NS	0.0018	0.18	NS[6]
Methylene chloride	3.6	NS	.00019[7]	0.15	0	NS	0	1.00	NS[6]
1,1,1-Trichloroethane	14.0	0.2	0.2	.0045	18.0	NS	41.8	.0023	NS[6]
Trichloroethene	290	.005	.005	.0061	21.9	NS	0.081	7.30	NS[6]
Vinyl chloride	.410	.002	.002	ND	NS	NS	0.002	0.15	NS[6]

NOTE:

Unit of Concentration for all federal and state standards is mg/L or mg/kg (ppm).

1 Primary Drinking Water Standard, Maximum Contaminant Level (40 CFR 141 and State Regulations State of Missouri 10 CSR 60-4,100)

2 Federal Water Quality Criteria for Protection of Fresh-Water Aquatic Life (USEPA, 1986b)

3 Federal Water Quality Criteria (FWQC) for Fish Ingestion (USEPA, 1986b)

4 Safe Water Drinking Act Maximum Contaminant Level Goal

5 State of Missouri Water Quality Standards

6 Health based risks associated with soils are presented in Section 6.0 and Appendix B

7 Missouri Water Quality Standard for halogenated methanes

ND = Not detected

NS = No standard established

6.2 EXPOSURE ASSESSMENT

Exposure assessment involves analysis of the following factors which will affect the quantification of risks: location of contamination, contaminant concentrations, exposure pathways, affected populations, and exposure frequency.

As discussed previously, contamination was detected in all media: air, surface soils, subsurface soils, ground water, and surface water in utilities. However, the concentrations varied significantly depending on whether the location was onsite or offsite. As a result, risks were calculated for each media depending on location and known concentration at that location. Location was further defined for ground water as to whether the ground water originated from the unconsolidated/fractured shallow bedrock (UFSB), the shallow bedrock (SBR), or the deep bedrock (DBR). For example, risks were quantified for ingestion of ground water from the DBR for both the maximum onsite concentration and for the maximum offsite concentration.

With the contamination present in all media both onsite and offsite, many pathways for exposure to the contaminants were evaluated based on current and future conditions. Table 5 lists the exposure pathways analyzed.

Exposure analysis classified the population into adults, children and infants. Exposure frequency varied depending on the pathway of exposure. For future exposure to contaminated ground water, exposure frequency was assumed to be seventy years for adults, twelve years for children and two years for infants. For exposures related to cleanup activities, the length of remediation was assumed to last forty years resulting in exposure frequencies of forty years for adults, twelve years for children and two years for infants. Exposure frequency was reduced for worker exposure in utilities. For example, the Southwestern Bell worker exposure was assumed to be 0.25 hours/day, 12 days/year for 40 years.

6.3 TOXICITY ASSESSMENT

Five of the seven indicator chemicals are classified as possible, probable or known human carcinogens with vinyl chloride being the known human carcinogen. In Appendix C, the cancer potency factors are presented for the indicator chemicals. These factors are used to calculate excess cancer risks associated with the site based on site contaminant concentrations. The EPA and MDNR consider individual excess cancer risks in the range of 1 in 10,000 (10^{-4}) to 1 in 10,000,000 (10^{-7}) as protective; however, the 1 in 1,000,000 risk level is used as the point of departure for setting cleanup levels.

TABLE 5

RELEASE SOURCE ANALYSIS AND EXPOSURE PATHWAYS AT THE REPUBLIC, MISSOURI SITE

Media	Chemical Source/ Release Mechanism	Release Probability	Potential Exposure Point	Potential Exposure Route	Chemical Detected at Exposure Point	Complete Exposure Pathway?
Soil	Surface soil/runoff	Low	Republic, MO, site	Absorption/ ingestion	Yes	Yes
	Surface soil/tracking	Moderate	Republic, MO, site	Absorption/ ingestion	Yes	Yes
	Surface soil/desorption onto receptor	High	Republic, MO, site	Absorption/ ingestion	Yes	Yes
	Subsurface soil/ desorption onto receptor	High	Republic, MO site/ subsurface utility lines	Absorption/ ingestion	Yes	Yes
Ground Water	Subsurface soil and disposal releases/ leaching or desorption	High	Republic, MO, site	Absorption/ ingestion	Yes	Yes
Air	Surface water/ volatilization	High	Utilities, sewage treatment plant effluent	Absorption	Yes	Yes
	Ground water and Surface soils/ volatilization	Low	Republic, MO, site	Inhalation	Yes	Yes
	Surface soils/ fugitive dust	Low	Republic, MO, site covered with gravel	Inhalation	Yes	No
	Ground water/ volatilization for stripping tower	High	Republic, MO, site	Inhalation	Yes	Yes
Surface Water	Surface water/effluent from sewage treatment plant	High	Discharge stream from sewage treatment plant	Absorption	Yes	Yes
	Surface water/effluent from air stripping tower and ground water discharge system	High	Surface water within utility	Absorption	Yes	Yes

Appendix C also lists the noncarcinogenic reference dose (RfD) levels for the indicator chemicals. The RfD is a concentration to which humans can be exposed to on a daily basis without adverse effect. The RfDs are used to calculate the Potential Hazard Index for each contaminant based on site contaminant concentrations. Potential Hazard Indices greater than 1.0 would be considered an unacceptable risk.

Cancer potency factors (CPFs) have been developed by EPA's Carcinogenic Assessment Group for estimating excess lifetime cancer risks associated with exposure to potentially carcinogenic chemicals. CPFs are multiplied by the estimated intake of a potential carcinogen to provide an upper-bound estimate of the excess lifetime cancer risk associated with exposure at that intake level. The term "upper bound" reflects the conservative estimate of the risks calculated from the CPF. Use of this approach makes underestimation of the actual cancer risk highly unlikely. Cancer potency factors are derived from the results of human epidemiological studies or chronic animal bioassays to which animal-to-human extrapolation and uncertainty factors have been applied.

Reference doses (RfDs) have been developed by EPA for indicating the potential for adverse health effects from exposure to chemicals exhibiting noncarcinogenic effects. RfDs are estimates of lifetime daily exposure levels for humans, including sensitive individuals. Estimated intakes of chemicals from environmental media (e.g., the amount of a chemical ingested from contaminated drinking water) can be compared to the RfD. RfDs are derived from human epidemiological studies or animal studies to which uncertainty factors have been applied (e.g., to account for the use of animal data to predict effects on humans). These uncertainty factors help ensure that the RfDs will not underestimate the potential for adverse noncarcinogenic effects to occur.

Through the defined exposure pathways, carcinogenic and noncarcinogenic risks exist for the exposed population due to each contaminant. Cumulative contaminant risks are also calculated and evaluated for exposed populations by simply adding the individual contaminant risks.

6.4 RISK CHARACTERIZATION

Quantified carcinogenic and non-carcinogenic risks are presented in Appendix D. The results for the risk assessment based on current conditions indicate that no unacceptable health risks are present. This determination is based on the fact that the UFSB and SBR aquifers are not presently used as a drinking water source. The deep bedrock aquifer near the site is no longer used as a drinking water source since Municipal Well Number 1 was removed from service.

However, future use of onsite and offsite ground water from any one of the three aquifers could pose unacceptable health risks at present contaminant levels. Dermal contact and/or ingestion of onsite ground water presents the greatest carcinogenic risk. Based on drinking the most contaminated ground water for seventy years, one additional person in ten (1.1×10^{-1}) has a chance of contracting cancer. The same exposure presents the maximum, noncarcinogenic hazard index of 2,292.

Risk analysis predicts that operation of an air stripper system will not pose an unacceptable threat to onsite workers or offsite residents as a result of airborne contaminants. This analysis was based on air modelling predictions for elevated ambient air concentrations of contaminants, on a ground water flowrate of 150 gallons per minute to the air stripper system, and on contaminant influent concentrations to the system derived from the pilot study. Also, no unacceptable health risks were identified in association with discharging the air stripper effluent into the sewer system.

No threatened or endangered wildlife were identified and, thus, no critical habitats are affected by the site contamination.

Actual or threatened releases of hazardous substances from this site, if not addressed by implementing the response action selected in this ROD, may present an imminent and substantial endangerment to public health, welfare, or, the environment.

SECTION 7.0 DESCRIPTION OF ALTERNATIVES

Alternative I: No Action

Alternative I is the no action alternative, required by the NCP and SARA, and is the baseline against which the effectiveness of other remedial alternatives are judged. Under Alternative I, no funds are expended for monitoring, control, or remediation of the site. The only technologies included in the no action alternative are site perimeter fencing and new Municipal Well 4C, both of which have already been constructed. The existing contaminant plumes in the three aquifers will not be remediated except through natural attenuation. The three plumes will increase and spread over larger areas.

Alternative II: Pump and treatment using air strippers with treated water discharged to Publicly Owned Treatment Works (POTW).

Major Components of the Remedial Alternative: The major features of this alternative include extraction of contaminated ground water from three aquifers, onsite physical/chemical treatment using air stripping to promote volatilization of the contaminants from the extracted ground water, and discharge of the treated effluent to the Republic POTW to undergo additional offsite treatment. The City of Republic will be asked to enact an ordinance to prevent construction of drinking wells in or near the contaminated plumes to prevent direct contact/ingestion of contaminated ground water before the remediation is complete.

The transport of materials through the subsurface via ground water was evaluated for the three hydrogeologic units defined: the unconsolidated/fractured shallow bedrock (UFSB), the shallow bedrock (SBR), and the deep bedrock (DBR). Transport in the UFSB was analyzed using analytical techniques because of the limited data base on the hydrogeologic parameters of the UFSB. Transport in the SBR and the DBR was analyzed using a numerical ground water and transport code to model the ground water flow.

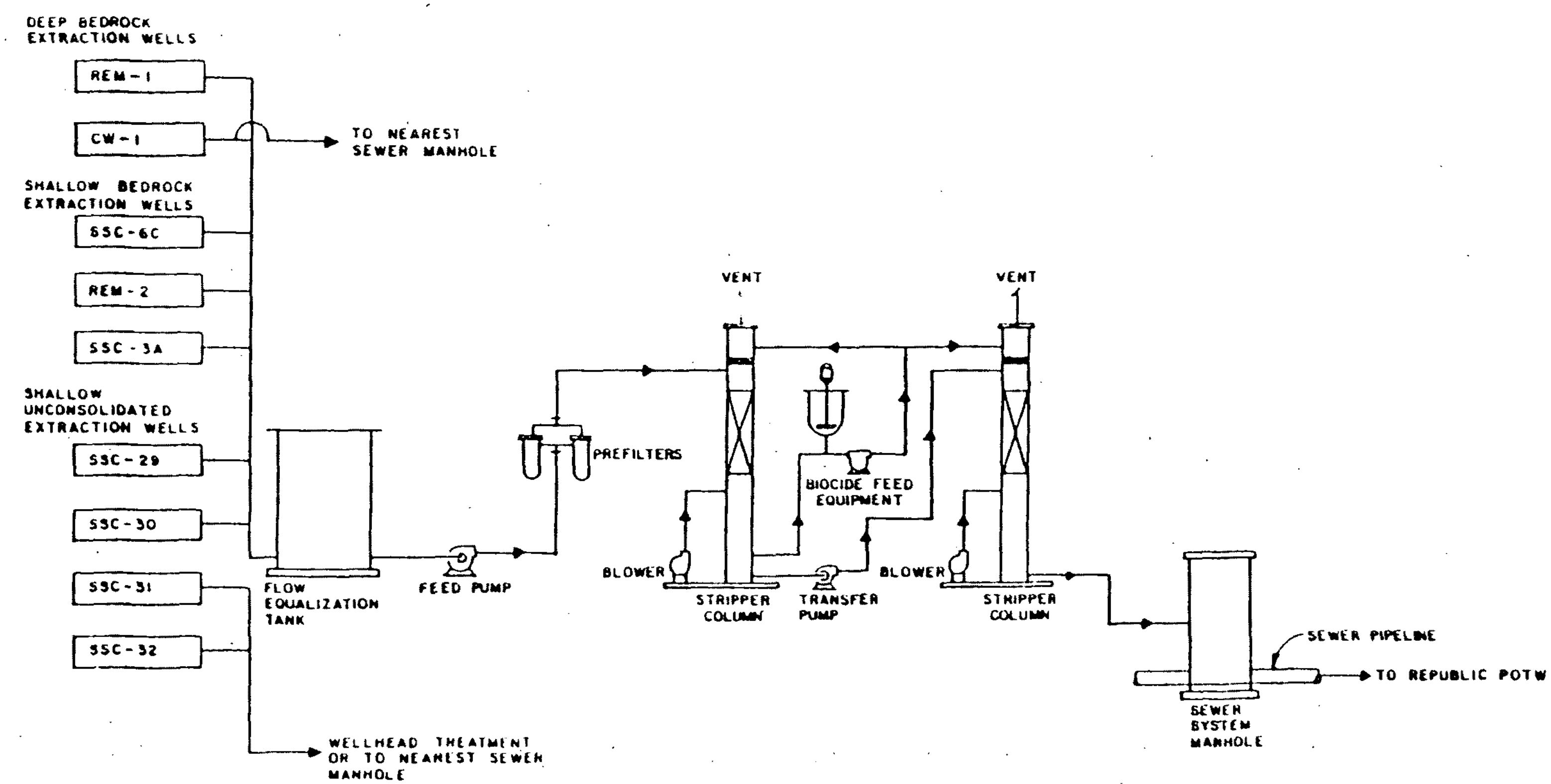
The total flow rate from all extraction wells is anticipated to range from 150 to 175 gpm. The extraction system for Alternative II consists of using existing and new wells for the three aquifer system. Two extraction wells will be used for collection of contaminated ground water from the DBR. For the SBR, three wells will be used. For the UFSB, four new extraction wells will be constructed.

Figure 11 diagrams the process flow for Alternative II. Contaminated ground water from onsite and from offsite extraction wells with TCE levels above 200 ug/l will be piped to the onsite air strippers for treatment. Ground water from wells with TCE levels below 200 ug/l will be discharged directly to the sewer. If the TCE levels in the ground water extracted from certain offsite wells are found to exceed 200 ug/l, the ground water will be pumped to a wellhead treatment system consisting of either a carbon adsorption system or air stripper units.

The air strippers were used during the RI/FS to provide pretreatment of fluids generated from onsite RI activities such as well construction and aquifer testing, and to initiate a pilot program to test the feasibility of proposed remedial actions. The average removal efficiency for TCE was 98 percent for each tower resulting in a total removal efficiency of over 99 percent.

Air stripper modifications may include Best Available Control Technology (BACT) for air emissions, depending on future federal and state air emissions regulations.

The stripper tower air emission rates will be evaluated on a frequent basis to verify that stripper tower emissions continue to pose no unacceptable public health risks. The need for an ambient air monitoring program will be evaluated during remedial design. The major ARARs are National Primary and Secondary Ambient Air Quality Standards (40 CFR Part 50) and state air quality De Minimis Emission Levels [10 CSR 6.060 (7)(A)].



ALTERNATIVE II
PROCESS FLOW DIAGRAM

FIGURE 11

The state has two ground water classifications in its water quality standards, VI and VII. Category VI limits apply if the aquifer recharge has an effect on surface water designated for aquatic life protection. The UFSB and the SBR systems are in this category. Category VII limits apply if aquifer recharge has a negligible effect on surface water designated for aquatic life protection. The DBR is in this category. Additionally, the state has a ground water protection strategy. The state's ground water protection goal is to maintain the quality and quantity of the state's ground water at the highest level practicable, as necessary to support present and future beneficial uses. The state of Missouri classifies all ground water as Class II, current and potential sources of drinking water and water having other beneficial uses. Class I and III are not recognized in the state.

When the remediation is complete, the ground water in all three aquifers will be restored for future use, by reducing the site contaminants in ground water to their respective ARAR levels. The area of attainment is the entire plume, since the soil source has been removed. Cleanup levels will be achieved in the entire plume. The major ARARs are federal National Primary Drinking Water Standards (40 CFR Part 141), state Maximum Inorganic Chemical Contaminant Levels (10 CSR 60-4.030), state Maximum Volatile Organic Chemical Contaminant Levels (10 CSR 60-4.100), and state water quality standards in ground water (10 CSR 20-7.031).

Management of Residuals. Treated effluent from the air strippers will be discharged to the Republic sewer system. The adequacy of the sewers to convey the treated effluent for the duration of the remedial action is uncertain. Moving the location where the effluent enters the sewers may alleviate some of this uncertainty. New sewers with larger capacities exist within 2,600 feet of the site and will require either a highway or a railway crossing. The discharge point to the sewer will be evaluated during remedial design.

Sewers have adequate capacity to handle the treated effluent flow, except possibly under the high infiltration/inflow conditions that can occur during rainstorms. Flow depth monitoring equipment will be installed in discharge sewer manholes so that extraction will cease during periods of high sewer flow.

From the site, the sewer will carry the treated effluent to the Publicly Owned Treatment Works (POTW), where additional aeration and mixing occurs. The POTW sludge amount will not increase due to the low biological oxygen demand (BOD)/solids loading and metals concentrations of the SSC site discharge. The POTW effluent is discharged to Dry Branch, the receiving stream. The POTW operates under a state NPDES permit which includes a TCE monthly average discharge limit of 2 ug/l. The plant should be able to accept the 150 to 175 gpm without adverse effects since the flow will be virtually free of organic/solids loading. However, during the predicted life of the remediation, if the projected growth of the city becomes a reality, the City of Republic will need to expand the plant's aeration capacity to meet the increasing organic/solids loading.

The major ARARs for the discharge component are the National Pretreatment Standards, 40 CFR Part 403, and the pretreatment standards of 200 ug/l TCE and 200 gallons per minute established by the City of Republic and the already existing NPDES permit for the POTW discharge to Dry Branch. The state water quality standards for aquatic life protection (10 CSR 20-7.031) are used to establish the discharge limits.

The estimated capital cost of the remedy is $274,800, with annual O&M costs estimated to be $445,300. Assuming a 10 percent discount rate, the present worth is $4,629,400.

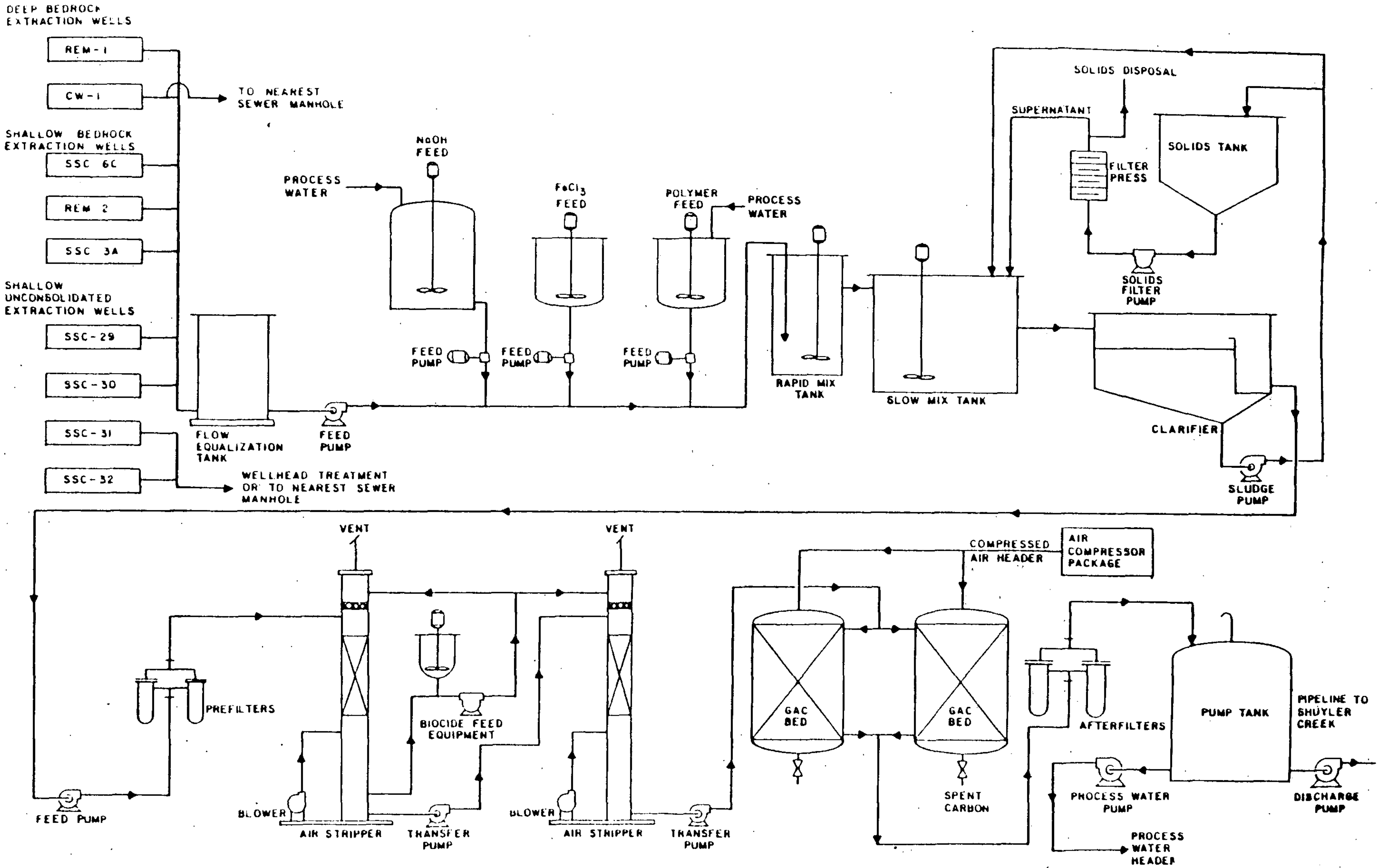
Alternative III: Pump and treatment using metals removal, air strippers, and carbon adsorption with treated water discharged to Shuyler Creek.

Major Components of the Remedial Alternative. The major features of this alternative includes extraction of contaminated ground water from three aquifers; onsite physical/chemical treatment using metals removal, existing air strippers, and carbon adsorption; and offsite discharge of the treated effluent through a pipeline to Shuyler Creek located approximately two miles south of the site.

The ground water extraction system will be identical to the extraction system described for Alternative II. The type and volume of waste treated, ground water classifications, cleanup levels, area of attainment, restoration timeframe, and major ARARs are the same as Alternative II.

Management of Residuals. Figure 12 diagrams the process flow for Alternative III. The treatment unit processes will consist of metals removal, air stripping, and carbon adsorption. The contaminated ground water will first pass through the metals removal facilities which will consist of flocculation/clarification facilities with a capacity of 150 gpm. Chemicals will be added to the ground water to form metal hydroxides which settle out in a clarifier. The clarifier will remove the flocculated metals and solids from the water. Excess metals sludge will be pumped to a sludge holding tank for storage, a filter press will dewater it, and the sludge will be disposed of in a RCRA approved hazardous waste landfill. After the metals are removed, the contaminated water is pumped to the air strippers for further treatment. The air strippers are sized to treat 150 gpm. The treated effluent from the air stripper is then pumped to the

FIGURE 12



ALTERNATIVE III
PROCESS FLOW DIAGRA

carbon adsorption facilities as a polishing step. The carbon adsorption facility has two contactors which hold granular activated carbon (GAC) and has a capacity of 150 gpm. The organic contaminants in the water adsorb or adhere to the carbon particles. When the carbon is spent, it is removed and replaced by a vendor specializing in this service. The major ARARs for the air emissions are National Primary and Secondary Ambient Air Quality Standards (40 CFR Part 50) and state air quality De Minimis Emission Levels [10 CSR 6.060 (7) (A)]. The major ARARs applicable to the disposal of residuals are the Solid Waste Disposal Act (SWDA), 42 USC Section 6901-6987.

The final treated effluent will be collected in an onsite tank and pumped through a discharge pipeline to Shuyler Creek. The pipeline would be constructed using standard open-cut trenching techniques, except where it passes under Highway 60. The exact route of the pipeline from the site to the creek will be determined during remedial design. The major ARAR applicable to this discharge will be an NPDES permit applied at Shuyler Creek. The state water quality standards for aquatic life protection (10 CSR 20-7.031) will be used to establish the discharge parameters and limits. Metals removal and carbon adsorption are needed for this alternative because it is anticipated that the direct discharge to Shuyler Creek will need to meet stringent discharge limits. Shuyler Creek is a low flow stream which provides little dilution, so the permit limits will be at or slightly higher than the Missouri water quality standards for aquatic life protection.

The estimated capital cost of the remedy is $2,471,100, with annual O&M costs estimated to be $977,200. Assuming a 10 percent discount rate, the present worth is $12,027,200. The estimated time to implement this remedy and to meet the cleanup goals is the same as for Alternative II. The health risks goals at the completion of the remedial action are also the same as Alternative II.

<u>ALTERNATIVE</u> <u>IV:</u> Pump and treatment using air strippers and carbon adsorption with treated effluent discharged to the deep bedrock aquifer as enhanced ground water contaminant recovery.

<u>Major Components of the Remedial Alternative</u>: The major features of this alternative includes extracting contaminated ground water from each of the three different aquifer systems, onsite physical/chemical treatment of the water using the existing onsite air strippers and new carbon adsorption facilities, and discharging the treated effluent through pipelines to three reinjection wells which are open to the deep bedrock as part of an enhanced ground water contaminant recovery system.

The ground water extraction system for Alternative IV is identical to the extraction system for Alternative II. The type and volume of waste treated, ground water classifications, cleanup levels, area of attainment, and major ARARs are the same as Alternative II. The restoration timeframe for the UFSB and the SBR is the same as for Alternative II. The time required to remediate the deep bedrock aquifer under Alternative IV is anticipated to be 10 to 30 years shorter.

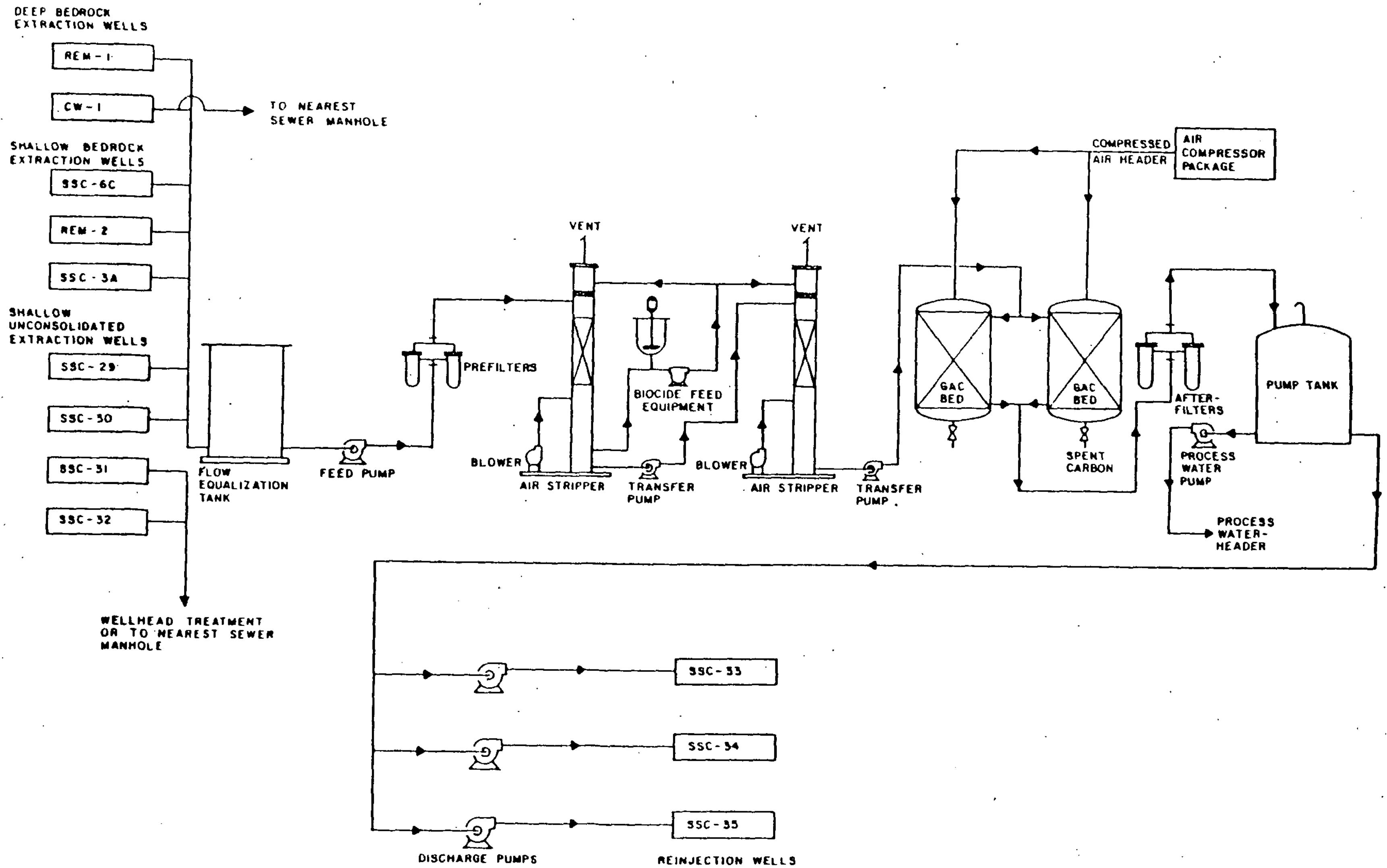
Management of Residuals. Figure 13 diagrams the process flow for Alternative IV. The treatment system will consist of air stripping and carbon adsorption. The existing air strippers will be identical to those proposed for Alternative II, and the new carbon adsorption facilities will be identical to those described in Alternative III. The major ARARs for the air emissions are National Primary and Secondary Ambient Air Quality Standards (40 CFR Part 50) and state air quality De Minimis Emission Levels [10 CSR 6.060 (7) (A)]. The major ARARs applicable to the carbon regeneration are the Solid Waste Disposal Act (SWDA), 42 USC Section 6901-6987.

Treated effluent will be collected in an onsite tank and pumped through discharge pipelines to three reinjection wells as part of an enhanced ground water contaminant recovery system. The reinjection wells will be cased down through the shallow unconsolidated system, shallow bedrock aquifer, and Northview shale layer. The wells will be open to the deep bedrock aquifer. The construction details and the exact locations of the three wells and their associated pipelines will be determined during remedial design. The major ARARS are Underground Injection Control (UIC) Regulations, 40 CFR Parts 144 - 147, and State UIC regulations, 10 CSR 20-6.090, Class III Mineral Resources Injection Production Well.

The estimated capital cost of the remedy is $1,323,600, with annual O&M costs estimated to be $665,100. Assuming a 10 percent discount rate, the present worth is $7,827,600. The estimated time to implement this remedy and to meet the cleanup goals is the same as for Alternative II, with the exception of the deep bedrock aquifer. This will be shorter. The health risks goals at the completion of the remedial action are also the same as for Alternative II.

SECTION 8.0 SUMMARY OF THE COMPARATIVE ANALYSIS OF ALTERNATIVES

Alternatives were developed to respond to the ground water contamination in each of the three aquifers. The alternatives described in the preceding section were evaluated using criteria related to factors mandated in Section 121 of CERCLA/SARA. The nine criteria are as follows:



ALTERNATIVE IV
PROCESS FLOW DIAGRAM

FIGURE 13

45

Threshold Criteria

- Overall Protection of Human Health and Environment addresses whether or not a remedy provides adequate protection and describes how risks through each pathway are eliminated, reduced or controlled through treatment, engineering controls, or institutional controls;

- Compliance with Applicable or Relevant and Appropriate Requirements (ARARs) addresses whether or not a remedy will meet all of the applicable or relevant and appropriate requirements of other Federal and State environmental statutes and/or provide grounds for invoking a waiver;

Primary Balancing Criteria

- Long-Term Effectiveness and Permanence refers to the magnitude of residual risk and the ability of a remedy to maintain reliable protection of human health and the environment over time once cleanup goals have been met;

- Short-Term Effectiveness refers to the speed with which the remedy achieves protection, as well as the remedy's potential to create adverse impacts on human health and the environment that may result during the construction and implementation period;

- Reduction of Toxicity, Mobility, or Volume through Treatment is the anticipated performance of the treatment technologies that may be employed in a remedy;

- Implementability is the technical and administrative feasibility of a remedy, including the availability of materials and services needed to implement the chosen solution;

- Cost includes capital, and operation and maintenance costs;

Modifying Criteria

- State Acceptance indicates whether, based on its review of the RI/FS and Proposed Plan, the State concurs, opposes, or declines comment on the preferred alternative;

- Community Acceptance which is assessed in the Responsiveness Summary which is attached to this Record of Decision (ROD), and which reviews the public comments received during the public comment period.

Each alternative was evaluated against the specific criteria described above to assess the relative performance of each alternative. This comparative analysis is summarized below:

Overall Protection of Human Health and the Environment:

Alternative I, the No Action Alternative, will not be protective of human health and the environment. The contaminant plume will migrate toward the currently uncontaminated municipal wells and present future health risks to ground water users. The existing contamination in the ground water already exceeds state and federal drinking water standards and state water quality standards for ground water.

Alternatives II, III, and IV will all be equally protective of human health and the environment by extracting and treating the contaminated ground water. To prevent unacceptable short-term impacts, city ordinances will prevent construction of new wells within or near the contaminant plumes to prevent ingestion of the contaminated water before the remediation is complete. The contaminants will be permanently removed from the ground water. All three alternatives will utilize treatment systems which include, as a minimum, an air stripping process to remove the contaminants of concern. Air modelling has been conducted which shows that the stripper tower emissions will not pose an unacceptable public health risk, so there are no cross-media impacts associated with the remedies. At the completion of the remediation, the site contaminants in all three aquifers will be reduced to their respective ARARs, thereby bringing the exposure levels within an acceptable risk range.

Compliance with ARARs:

Alternative I will not meet ARARs since the contaminant concentrations will not be reduced and no action will be taken. Alternatives II and III will meet their respective Applicable or Relevant and Appropriate Requirements (ARARs) of federal and state environmental laws; however, Alternative IV may not comply with a state statute. Alternatives II, III, and IV will reduce the ground water contamination to meet state and federal standards for drinking water supplies, state water quality standards for ground water, and existing state and federal air regulations. However, new air toxics regulations may require modification to the air stripping system.

Additionally, Alternative II will comply with pretreatment standards before discharging the treated effluent to the sewer system. The Publicly Owned Treatment Works (POTW), or the sewage treatment plant, has an existing National Pollutant Discharge Elimination System (NPDES) permit applied at Dry Branch.

Alternative III will treat the extracted ground water to meet National Pollutant Discharge Elimination System (NPDES) discharge limits to Shuyler Creek. Metals removal is needed for this alternative in anticipation of meeting stringent discharge limits established for the direct discharge to the low-flow stream.

Alternative IV may not comply with a state law which prohibits the disposal of wastewater via reinjection wells (577.155.1 RSMo). The applicant for the reinjection permit will need to demonstrate to the state how the alternative does not constitute disposal and how it will enhance ground water contaminant recovery.

No waiver from the ARARs is required to implement any of the active cleanup options.

Long-term Effectiveness and Permanence:

For Alternative I, the No Action Alternative, the plumes will continue to migrate and eventually, in the deep bedrock aquifer, contaminate Republic's water supply. No controls or monitoring of the aquifer will be provided.

Alternatives II, III, and IV will involve long term pump and treat remedies requiring approximately forty years. A five year review will be required because the remedies will result in hazardous substances remaining onsite above health-based levels during the remediation. At the completion of the remediation, the ground water in all three aquifers will be restored for future unrestricted use by reducing the site contaminants to their respective ARAR levels.

Alternatives II, III, and IV use air strippers in their ground water treatment systems. Countercurrent packed tower (CCPT) air stripping is a well documented and established technology for VOC removal. As an example, CCPT air strippers can remove greater than 99 percent of TCE in solutions. The actual performance of the two air strippers operating in series was evaluated during a period of aquifer testing by the PRP at the site in 1988. The average TCE removal using both towers was 99.89 percent. VOC removal efficiency is not influenced by changes in concentration and is independent of air temperature. Operational problems which can occur are biological growth within the packing material, corrosion problems caused by the introduction of oxygen, noise from air blowers, and freezing within the stripper media during winter months. Possible solutions include biological growth inhibitors, corrosion resistant materials, silencers or mufflers, and housing the entire stripper unit in a heated enclosure.

Alternative II will use the POTW as a secondary treatment system for the air strippers. The POTW is expected to be capable of handling the discharge from the site without adverse effects since the flow will be virtually free of organic/solids loading. However, if the projected growth of the city becomes a reality, the City of Republic will need to expand the plant's aeration capacity to meet the increasing organic/solids loading during the predicted life of the remediation.

The treatment system for Alternative III consists of metals removal and carbon adsorption facilities in addition to air strippers. The discharge to the creek will require frequent monitoring to ensure that the anticipated stringent NPDES limits are met. Additional operations management to plan and obtain chemicals for the metals removal facilities and replacement carbon will also be required. Residuals will be generated by the carbon adsorption facilities in the form of spent carbon and by the metals removal facilities in the form of metals sludge. The spent carbon will be regenerated and the metals sludge will be properly disposed of at a RCRA approved disposal facility.

Alternative IV will use carbon adsorption facilities as secondary treatment prior to reinjection in deep bedrock aquifer wells as part of an enhanced ground water contaminant recovery system. Carbon adsorption is a conventional treatment process that will remove a broad spectrum of organic compounds from dilute aqueous solutions. Granular activated carbon (GAC) filtration generally will remove 99 percent or more of VOCs. There are several disadvantages to GAC use, the most significant being the short contaminant breakthrough times which result in frequent carbon replacement. Spent carbon, contaminated with VOCs, must be regenerated or disposed of in a RCRA facility. Influent contaminants and concentrations can significantly affect the GAC treatment performance. When the GAC adsorbent capacity nears exhaustion, previously adsorbed material may be desorbed into the treated water if a reduction in the influent concentration occurs. The performance of GAC filters is more consistent if influent quality is constant. Flow equalization and blending facilities may be necessary to ensure optimum treatment. Clogging of GAC surfaces and reduction of treatment efficiency can occur if the influent contains suspended solids or oxidized iron. Chlorination may be required to control bacterial growth which can occur in GAC filters.

Alternative II is the most reliable. It will require periodic monitoring of the SSC discharge and the POTW to ensure that pretreatment and NPDES standards are not being exceeded. It does require the least amount of monitoring in comparison to the other alternatives. The POTW sludge amount will not increase due to the low biological oxygen demand (BOD)/solids loading of the site discharge, so this alternative will produce no residuals.

Reduction of Toxicity, Mobility, and Volume:

Alternative I will not reduce the toxicity or mobility of the contaminants, and the volume of contaminated ground water will increase as the plume migrates.

All three of the remaining alternatives equally reduce the mobility and volume of the contaminants. Alternatives II, III, and IV will irreversibly reduce contaminant levels in all three aquifers to levels which satisfy ARARs. Air stripping will remove the volatile organics from the ground water and volatilize them. Over ninety-nine (99%) percent of the VOCs are removed by the air stripping process. Mathematical air modelling has shown that the air emissions from the air strippers will pose no long term unacceptable health risks to area residents. Alternatives II uses the POTW as a finishing step to further reduce TCE levels to below 2 ppb, the limit established for TCE in the NPDES permit for the POTW discharge at Dry Branch. Alternative III will produce a residual metals sludge which will be disposed of in a RCRA disposal facility, thereby reducing its mobility but not its toxicity. Regeneration of the spent carbon residual from the carbon adsorption facilities will destroy the VOCs. Alternative IV uses carbon adsorption as the finishing step to reduce the TCE levels to meet the Underground Injection Control (UIC) permit requirements. GAC filtration will remove 99 percent or more of TCE from dilute aqueous solutions. Any volatiles absorbed by the carbon will be destroyed during carbon regeneration.

Future use of onsite and offsite ground water from any one of the three aquifers could pose unacceptable health risks at present contaminant levels. Dermal contact/ingestion of onsite ground water poses the greatest principal threat. The treatment processes employed by Alternatives II, III, and IV will reduce the inherent hazards posed by the principal threats at the site.

Short-Term Effectiveness:

Alternative I will not increase risks to the community, environment, or workers since no construction activities are planned. Potential environmental impacts from the existing conditions will not be changed.

Alternatives II, III, and IV provide adequate and approximately equal protection to the community and workers during the remedial action. City ordinances placing limits on new well construction in or near the plume will be implemented for all three alternatives to prevent ingestion of the contaminated ground water during the remediation. Alternatives II, III and IV will require construction of onsite and offsite extraction wells. Any release of volatiles during well construction will rapidly disperse and not pose a public health risk. The site perimeter fence will minimize risks to the community posed by onsite construction of the new treatment facilities required for Alternatives III and IV. The gravel already covering the site will minimize dust emissions. Additionally, Alternative III will involve construction of the approximately two-mile discharge pipeline from the site to Shuyler Creek. Construction of the pipeline will pose normal risks associated with construction of buried pipelines. Alternative IV will include construction of the new reinjection wells. Short-term effects associated with the construction of the new reinjection wells will be the same as those associated with the drilling of the offsite extraction wells.

Drawdown of the aquifer, which is normal during ground water extraction, will not create any significant environmental impacts under Alternatives II, III and IV. The increased flow in Shuyler Creek from Alternative III will not create any unacceptable environmental impacts. For Alternative IV, reinjection into the deep bedrock aquifer may locally change the ground water gradient and flow direction but will not create any significant environmental impacts.

Implementability:

Alternative I does not use any controls or technologies which will require coordination with other agencies.

All three alternatives are approximately equal in terms of technical feasibility, administrative feasibility, and availability of services and materials. Alternative II is slightly more feasible technically and administratively. Alternatives II, III, and IV should not be difficult to implement. The services and required materials are readily available. The treatment technologies used in Alternatives II, III, and IV will meet the statutory preference for treatment as the principal element of the remedial action. All three alternatives will require coordination with MDNR to comply with any new air toxics regulations.

Alternative II will require the least coordination with MDNR, EPA, and the City of Republic since minimal construction is planned. Alternatives III and IV will require more construction than Alternative II. Alternative III will require coordination with the state and local highway departments to cross underneath Highway 60 with the discharge pipeline. Obtaining a NPDES permit will also be required to discharge to Shuyler Creek. Alternative IV will require coordination with MDNR to obtain a reinjection permit, and this may violate a state statute which prohibits the disposal of wastewater via reinjection wells. The applicant for the reinjection permit will need to coordinate closely with the MDNR to ensure that the statute is not violated and to demonstrate how the reinjection will enhance ground water contaminant recovery. Reinjection wells have not been used extensively in the State of Missouri as a means of plume management.

Costs:

Alternative I will have zero cost.

Alternative II will have an estimated capital cost of $274,800, an estimated annual operation and maintenance (O&M) cost of $445,300, and an estimated implementation time frame of 40 years. Assuming a 10 percent discount rate, the present worth is $4,629,400.

Alternative III will have an estimated capital cost of $2,471,100, an estimated annual O&M cost of $977,200, and an implementation time frame of 40 years. Assuming a 10 percent discount rate, the present worth is $12,027,200.

Alternative IV will have an estimated capital cost of $1,323,600, an estimated annual O&M cost of $665,100, and an estimated implementation time frame of 40 years. Assuming a 10 percent discount rate, the present worth is $7,827,600.

Alternative II is the least costly. Alternative III is the most costly.

State Acceptance:

Representing the State of Missouri, the Missouri Department of Natural Resources' selected Alternative II in the proposed plan as its preferred alternative. The state is the lead agency for this site. However, under the Superfund law, it is EPA who must make the decision, in consultation with the state, on what the final remedy will be. MDNR has concurred with EPA's final remedy selection.

Community Acceptance:

The reservations, concerns, and supporting or opposing comments of the community on the RI/FS, the Proposed Plan, and other information in the administrative record were made known to the State of Missouri and EPA during the thirty day comment period and the public meeting with the community on August 24, 1989. The public's comments will be addressed in the responsiveness summary, which is a component of this Record of Decision for the site.

SECTION 9.0 THE SELECTED REMEDY

Based upon consideration of the requirements of CERCLA, the detailed analysis of the alternatives, and public comments, both EPA and the State of Missouri have determined that Alternative II: Ground Water Pump and Treatment using Air Strippers with Treated Water discharged to Publicly Owned Treatment Works (POTW) is the most appropriate remedy for the Solid State Circuits Site in Republic, Missouri.

The volume of volatile organic compound (VOC) contaminated ground water that will be treated by air stripping differs in each aquifer. The estimated volume of water contained within the plume north of Highway 60 is 15 million gallons in the unconsolidated residual soils and fractured shallow bedrock (UFSB). The estimated volume of waters in the shallow bedrock (SBR) containing VOCs is 790,000 gallons. For the deep bedrock (DBR), the estimated volume of VOCs is 42 million gallons. The volume of water that must be treated to remediate a given volume of water is estimated to be about ten times the contaminated volume. Approximately 99 percent of the VOCs will be removed by air stripping. The additional one percent will be discharged to the POTW to undergo secondary treatment to further reduce the VOC concentration. The air stripping process will transfer the VOCs from the ground water to the air stream for release to the atmosphere. Air modelling of the airborne concentrations predicted that the potential cancer risk and the hazard index ratios are acceptable.

The extraction system for Alternative II consists of using existing and new wells for the three aquifer system. Two extraction wells, onsite REM-1 and offsite CW-1, will be used for collection of contaminated ground water from the deep bedrock system. Several other deep bedrock wells are available for use as extraction wells; however, REM-1 and CW-1 will be the main wells used. For the shallow bedrock aquifer, onsite wells SSC-6C and REM-2 and offsite well SSC-3A will be used for extraction of the contaminant plume. For the shallow unconsolidated system, new extraction wells will be constructed. These new wells will be designated SSC-29 through SSC-32. SSC-29 will be located onsite, SSC-30 will be near CW-1, and the remaining two will be located to intercept and capture the entire shallow unconsolidated system contaminant plume. The exact well design and location will be determined during remedial design. Although not selected for a detailed analysis, the ground water collection scenario which consists of extraction wells and a subsurface interceptor trench and drain may be retained for consideration during remedial design/remedial action, or after additional site characterization has been completed. A change will be made in the contaminant recovery method for the shallow unconsolidated system only if the four extraction wells are not controlling and recovering the contaminants.

The total flow rate from all extraction wells is anticipated to range from 150 to 175 gpm. The UFSB can be pumped at rates ranging from 6 to 15 gpm. The SBR will not be capable of supplying any more than 1 to 5 gallons per minute per well location. In the deep bedrock aquifer, analyses indicate that a remedial pumping rate of 50 gpm will control ground water flow beneath the site under current municipal pumpage conditions. The numerical modeling also indicates that remedial pumpage of 50 gpm will control ground water flow even with the increased demands projected for the year 2005. The remedial pumping rate may need to be increased as municipal pumpage rates exceed the simulated 2005 pumpage of 150% of 1988 pumpage. The actual pumpage rate increase required will be based on water level monitoring of the deep bedrock aquifer.

Previously, Figure 11 diagrammed the process flow for Alternative II. The treatment system for Alternative II will consist of using the two existing air strippers located onsite. Contaminated ground water from onsite and from offsite extraction wells with TCE levels above 200 ug/l will be piped to the onsite air strippers for treatment. Ground water from wells with TCE levels below 200 ug/l, which includes CW-1 and may include SSC-31 and SSC-32, will be discharged directly to the sewer. If the TCE levels in the ground water extracted from these wells are found to exceed 200 ug/l, the ground water from CW-1 will be pumped to the onsite treatment system and ground water from SSC-31 and SSC-32 will be pumped to a wellhead treatment system consisting of either a carbon adsorption system or air stripper units. Periodic monitoring will be performed to verify that TCE levels are acceptable. The air strippers will remove the volatile organic contaminants from the ground water by forcing air countercurrently through the waste stream, and the volatile, dissolved gases will be transferred to the air stream for release to the atmosphere. The maximum rated flow capacity of each air stripper is 150 gallons per minute.

The air strippers were used during the RI/FS to provide pretreatment of fluids generated from onsite RI activities such as well construction and aquifer testing, and to initiate a pilot program to test the feasibility of proposed remedial actions. Ground water TCE concentrations pumped to the stripper system ranged from 2,100 ug/l to 4,900 ug/l. The maximum TCE concentration in the discharge from the air stripper system was 26.0 ug/l. The minimum TCE removal efficiency was 99.8 percent during the pilot study. Air stripper modifications may include a Best Available Control Technology for emissions, dependent on future federal and state air emissions regulations.

Treated effluent from the air strippers will be discharged to a manhole adjacent to the site. Sewer pipelines adjacent to the site consist of eight inch diameter vitrified clay pipe. The adequacy of the sewers to convey the treated effluent for the duration of the remedial action is uncertain. The sewer system has the capacity to accept the estimated site discharge flow of 150 gallons per minute. However, during rainfall events, the city has experienced sewer backup problems. The Main Street sewer is the smallest line in the system and the most likely to experience capacity problems during rainfalls. The obvious site discharge point to the sewer would be into the Main Street sewer. Also, the Main Street sewer is an old, vitrified clay pipe line with many cracks and faults. Moving the location where the effluent enters the sewers may alleviate some of this uncertainty. New sewers with larger capacities exist within 2,600 feet of the site and will require either a highway or a railway crossing. The discharge point to the sewer will be evaluated during remedial design. Sewers have adequate capacity to handle the treated effluent flow, except possibly under the high infiltration/inflow conditions that can occur during rainstorms. Flow depth monitoring equipment will be installed in discharge sewer manholes so that extraction will cease during periods of high sewer flow.

From the site, the sewer will carry the treated effluent to the Publicly Owned Treatment Works (POTW), where additional aeration and mixing occurs. The POTW effluent is discharged to Dry Branch, the receiving stream. The POTW operates under a state NPDES permit which stipulates a TCE monthly average discharge limit of 2 ug/l. Analysis of the POTW, into which the sewer system discharges, indicates that discharge from the site of up to 200 gallons per minute and 200 ug/l TCE will not adversely effect the operation of the POTW. Also, metals concentrations detected in ground water are well below any pretreatment standards and, thus, metals removal of the ground water is not required before discharge to the POTW. Both of these observations are supported by the fact that the POTW experienced no problems while accepting site discharge during the pilot study.

The Republic POTW has a design average flow of 926,880 gallons per day (gpd) and a peak flow of 7.34 million gallons per day (mgd). More important design parameters are the design organic and solid loading factors, since they limit the plant's capacity and capability to treat and therefore meet NPDES requirements. Flows to the plant can be considerably higher than the design flow and still provide the required treatment so long as the organic and solid loadings are not exceeded. The site discharge is ground water and does not add to the organic and solid loads on the POTW.

Computer modelling of the Republic POTW was conducted for an influent flow consisting of the designed flow of 0.8 mgd at the design organic and solid loadings plus 0.66 mgd of water free of organic and solid loads. The results indicate that the plant could handle this total flow of 1.46 mgd without deterioration of its treatment capabilities merely by modifying its operational regime. Adding the site discharge at 150 gallons per minute (0.216 mgd) to the design flow produces a total flow of 1.114 mgd which is well within the modelled capacity of 1.46 mgd.

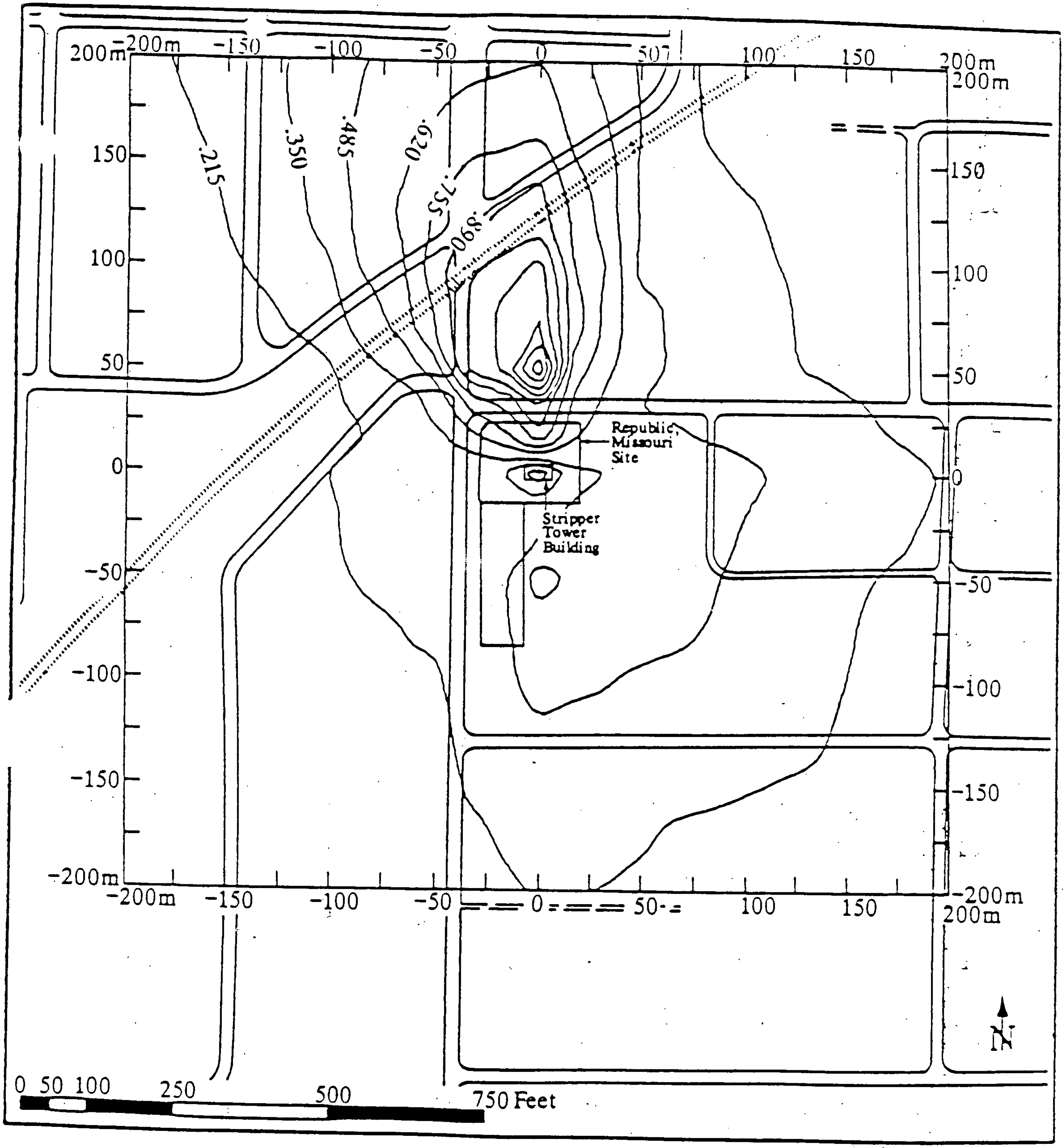
To address air emission concerns related to the air stripper system, computer modelling was conducted to determine elevated VOC concentrations in the ambient air. The Industrial Source Complex Long Term (ISCLT) model was used. The ISCLT is an EPA air quality dispersion model which uses historic meteorological data for the area of interest and site specific chemical data to estimate potential contaminant concentrations at predicted locations of maximum effect.

The meteorological data from Springfield, Missouri and emission rates calculated from the pilot study were used in the ISCLT modelling effort. The model solves for the distribution of contaminants in the air at ground level. Ten locations are identified by the model as those points predicted to have the highest concentration. Figure 14 shows the TCE air concentration based on a ground water pumping rate of 150 gallons per minute and at the maximum predicted emission rate from the air stripper towers. The predicted, maximum TCE location and concentration is due north of the site at 1.57 micrograms per cubic meter.

The estimated capital cost of the remedy is $274,800, with annual O&M costs estimated to be $445,300. Assuming a 10 percent discount rate, the present worth is $4,629,400. Tables 6, 7 and 8 present in detail the estimated costs of the remedial action. Some changes may be made to the remedy as a result of the remedial design and construction processes, thereby affecting the estimated costs. Such changes, in general, reflect modifications resulting from the engineering design process.

Remediation Goals

The purpose of this response action is to prevent potential exposure to contaminated ground water, protect uncontaminated ground water for future use by preventing further migration of the contaminated ground water plumes, and restore contaminated ground water for future use by reducing the site contaminants to their respective ARAR levels. Existing conditions at the site have been determined to pose an excess lifetime cancer risk as high as one person in ten and a lifetime non-carcinogenic risk as high as 2,292 from future direct contact/ingestion of onsite ground water. This risk relates to the VOC concentrations (primarily TCE) in ground water which averages 40,000 ug/l onsite in the UFSB, 30,000 ug/l onsite in the SBR, and 3,000 ug/l in the DBR. This remedy will address all ground waters with contaminants above their respective ARAR levels. As an example, TCE in excess of 5 ug/l will be remediated. At the completion of the remediation, the level of site contamination remaining in ground



PREDICTED CONCENTRATION CONTOURS FOR A TCE AIR EMISSION RATE OF 34.76 MILLIGRAMS PER SECOND AT A FLOW RATE OF 150 GALLONS PER MINUTE

Model Run I
Stack Height = 7.15m
Model Area Grid Shown in Meters

Contour Interval = .135ug/m^3

FIGURE 14

REPUBLIC, MISSOURI SITE
FEASIBILITY STUDY

FINAL GROUNDWATER ALTERNATIVES

PRESENT WORTH ANALYSIS

ALTERNATIVE	DURATION (YRS)	CAPITAL COST	ANNUAL COST	PRESENT WORTH		
				5% Discount Rate	8% Discount Rate	10% Discount Rate
II	40	$274,800	$445,300	$7,915,700	$5,584,800	$4,629,400
III	40	$2,471,100	$977,200	$19,239,000	$14,123,800	$12,027,200
IV	40	$1,323,600	$665,100	$12,736,100	$9,254,700	$7,827,600

TABLE 6

REPUBLIC, MISSOURI SITE
FEASIBILITY STUDY

FINAL ALTERNATIVE II
DISCHARGE TO POTW

CAPITAL COSTS

ITEM	QUANTITY	UNITS	UNIT PRICE ($)	TOTAL ($)
Extraction Wells (existing)	3	EA	0	0
Extraction Wells (new)	4	EA	30,000	120,000
Extraction Well Pumps (5 gpm)	4	EA	1,000	4,000
Ex Well Disc Piping-2" DBL Wall PVC	0	LF	50	0
Disc Piping to POTW-3" (existing)	150	LF	0	0
SUBTOTAL				$124,000
TREATMENT FACILITIES (150 GPM)				
Flow Equalization Tank (existing)	1	EA	0	0
Feed Pump to Pre-Filters(existing)	2	EA	0	0
Pre-Filters	1	LS	4,700	4,700
Air Stripper Package (existing)	1	EA	0	0
Biocide Feed Package	1	LS	13,650	13,700
Pre-Engr Bldg (20'x 30' existing)	600	SF	0	0
SUBTOTAL-TREATMENT EQUIPMENT				$18,400
Piping (20%)				3,680
Electrical (20%)				3,680
Instrumentation (30%)				5,520
Civil/Site Work (15%)				2,760
TREATMENT FACILITIES-SUBTOTAL				$34,000
CONSTRUCTION-SUBTOTAL				$158,000
Bonds and Insurance (5%)				7,900
Bid Contingencies (15%)				23,700
Scope Contingencies (20%)				31,600
CONSTRUCTION TOTAL				$221,200
Permitting and Legal (7%)				15,500
Construction Services (8%)				17,700
TOTAL-IMPLEMENTATION				$254,400
Engineering Design Costs (8%)				20,400
TOTAL CAPITAL				$274,800

TABLE 7

REPUBLIC, MISSOURI SITE
FEASIBILITY STUDY

FINAL ALTERNATIVE II
DISCHARGE TO POTW

ANNUAL OPERATION AND MAINTENANCE COSTS

OPERATION COSTS

Power Costs-Assumptions: Electrical Cost = $0.06/KWHR
Pump and Motor Efficiency = 0.6

Unit	Number	Flow (GPM)	Head (FT)	Total HP	Annual Cost
Extraction Well Pump--REM-1	1	50	325	6.84	2,700
Extraction Well Pump--CW-1	1	75	330	10.42	4,100
Extraction Well Pump--SSC-3A	1	75	130	4.10	1,600
Extraction Well Pump--SSC-6C	1	5	125	0.26	100
Extraction Well Pump--SSC-29	1	5	75	0.16	100
Extraction Well Pump--SSC-30	1	5	90	0.19	100
Extraction Well Pump--SSC-31	1	5	90	0.19	100
Extraction Well Pump--SSC-32	1	5	95	0.20	100
Feed Pump to Pre-Filters	1	150	30	1.89	700
Air Stripper Transfer Pump	1	150	30	1.89	700
Air Stripper Blower	2	--	--	3.00	2,400

SUBTOTAL-POWER		$12,700
Operation Labor (1/2 of 1 men, 2 shifts/day, 8 hour shift, 365 days/year)	2920 Hours @ $25.00/HR =	73,000
Chemicals		
Biocide		10,000
Sewer Charges	150 GPM @ $1.25/1000gal =	98,600
OPERATION SUBTOTAL		$194,300

MAINTENANCE COSTS

PARTS		10,000
LABOR		
Treatment Facilities (1/2 of 1 men, 1 shift/day, 8 hour shift, 365 days/year)	1460 Hours @ $25.00/HR =	36,500
Extraction Wells and Piping (1/2 of 1 men, 1 shift/day, 8 hour shift, 365 days/year)	1460 Hours @ $25.00/HR =	36,500
MAINTENANCE SUBTOTAL		$83,000

MONITORING COSTS

Treatment Monitoring		
Analysis (2 Key Points, 1 time/week, 52 weeks/yr)	104 Samples @ $300.00 =	31,200
Groundwater Monitoring		
Analysis (Samples Taken Quarterly)	32 Samples @ $300.00 =	9,600
MONITORING SUBTOTAL		$40,800

OPERATIONS, MAINTENANCE, MONITORING SUBTOTAL	$318,100
UNIT COST CONTINGENCIES (10%)	31,800
SCOPE CONTINGENCIES (15%)	47,700
ADMINISTRATIVE (15%)	47,700
ANNUAL OPERATION AND MAINTENANCE COSTS	$445,300

TABLE 8

waters at or below their ARAR levels will correspond to an excess lifetime cancer risk at or near 1 x 10^{-6} through the exposure routes of direct contact/ingestion.

SECTION 10.0 STATUTORY DETERMINATIONS

Under its legal authorities, EPA's primary responsibility at Superfund sites is to undertake remedial actions that achieve adequate protection of human health and the environment. In addition, section 121 of CERCLA establishes several other statutory requirements and preferences. These specify that when complete, the selected remedial action for this site must comply with applicable or relevant and appropriate environmental standards established under Federal and State environmental laws unless a statutory waiver is justified. The selected remedy also must be cost effective and utilize permanent solutions and alternative treatment technologies or resource recovery technologies to the maximum extent practicable. Finally, the statute includes a preference for remedies that employ treatment that permanently and significantly reduce the volume, toxicity, or mobility of hazardous wastes as their principal element. The following sections discuss how the selected remedy meets these statutory requirements.

10.1 Protection of Human Health and the Environment

The selected remedy protects human health and the environment through extraction and treatment of the VOC contaminated ground water. The contaminants will be permanently removed from the ground water by air stripping. The volatile dissolved gases will be transferred to the air stream for release to the atmosphere.

Extraction of the VOC contaminated ground water also will eliminate the threat of exposure to the most mobile contaminants from direct contact or from ingestion of contaminated ground water. The future carcinogenic risks associated with these exposure pathways are as high as 1.1 x 10^{-1}, or one person in ten, for TCE. By extracting the contaminated ground water and treating it by air stripping, the cancer risks will be reduced to about 1 x 10^{-6} and an Hazard Indices (HI) ratio of less than 1. A numerical computer model was utilized to predict the highest airborne concentrations emitted from the air strippers. The location with the highest concentrations was used to evaluate potential health risks. The highest cancer risk is 6.5 x 10-6 and the highest HI ratio is 0.3997. These levels are within the range of acceptable exposure levels of between 10^{-4} and 10^{-7} and an HI ratio of less than 1. There are no short-term threats associated with the selected remedy that cannot be readily controlled. In addition, no adverse cross-media impacts are expected from the remedy.

10.2 Compliance with Applicable or Relevant and Appropriate Requirements

The selected remedy of extraction, onsite physical/chemical treatment, and discharge of the treated effluent to the POTW will comply with all applicable or relevant and appropriate chemical, action, and location specific requirements (ARARs). The ARARs are presented below.

Action-specific ARARs:

- National Primary and Secondary Ambient Air Quality Standards (40 CFR Part 50)
- State air quality De Minimis Emission Levels [10 CSR 6.060(7)(A)];
- State water quality standards for aquatic life protection (10 CSR 20-7.031) incorporated into the NPDES permit for the POTW discharge to Dry Branch;
- National Pretreatment Standards, 40 CFR Part 403; and,
- Pretreatment standards of 200 ug/l and 200 gpm established by the City of Republic for the discharge of treated SSC effluent to the POTW.

Chemical-specific ARARs:

- Federal Maximum Contaminant Levels for inorganic and volatile organics in drinking water supplies (40 CFR Part 141);
- State Maximum Inorganic Chemical Contaminant Levels (10 CSR 60-4.030) for public water systems;
- State Maximum Volatile Organic Chemical Contaminant Levels for public water systems (10 CSR 60-4.100); and,
- State water quality standards for inorganic and volatile organics in ground water (10 CSR 20-7.031).

Location-specific ARARs:

- None

Other Criteria, Advisories or Guidance To Be Considered for This Remedial Action (TBCs):

- EPA and the State of Missouri have agreed to incorporate a local ordinance to prohibit construction of new water supply wells in or near the contaminant plumes until the remediation is complete. This will prevent direct contact and/or ingestion of contaminated ground water.

10.3 Cost-Effectiveness

The selected remedy is cost-effective because it has been determined to provide overall effectiveness proportional to its costs, the net present worth value being $4,629,400. The selected remedy is the least costly of the Alternatives II, III and IV, which are equally protective of human health and the environment.

10.4 Utilization of Permanent Solutions and Alternative Treatment Technologies (or Resource Recovery Technologies) to the Maximum Extent Practicable

The State of Missouri and EPA have determined that the selected remedy represents the maximum extent to which permanent solutions and treatment technologies can be utilized in a cost-effective manner for the Solid State Circuits Site. Of those alternatives that are protective of human health and the environment and comply with ARARs, the State of Missouri and EPA have determined that this selected remedy provides the best balance of tradeoffs in terms of long-term effectiveness and permanence, reduction in toxicity, mobility, or volume achieved through treatment, short-term effectiveness, implementability, cost, also considering the statutory preference for treatment as a principal element and considering State and community input.

Alternative II reduces the toxicity, mobility, and volume of the contaminants in the ground water; complies with ARARs; provides short-term effectiveness; and protects human health and the environment equally as well a Alternatives III and IV. In terms of long-term effectiveness, Alternative II is more reliable backup to the stripper units and because it does not generate any residuals. Alternative II will be easier to implement technically because it requires less construction and administratively because it will require less coordination with relevant agencies. Finally, and importantly, Alternative II costs the least of the equally protective alternatives. The major tradeoffs that provide the basis for this selection decision are long-term effectiveness, implementability, and cost. The selected remedy is more reliable and can be implemented more quickly, with less difficulty and at less cost than the other treatment alternatives and is therefore determined to be the most appropriate solution for the contaminated ground waters at the SSC site.

The State of Missouri is in concurrence with the selected remedy. Although public comments were received concerning the capacity of the community's POTW, those comments are fully addressed in the Responsiveness Summary.

The Proposed Plan for the SSC site was released for public comment on August 14, 1989. The Proposed Plan identified Alternative II as the preferred alternative. EPA reviewed all written and verbal comments submitted during the public comment period. Upon review of these comments, it was determined that no significant changes to the remedy, as it was originally identified in the Proposed Plan, was necessary.

10.5 Preference for Treatment as a Principal Element

By treating the VOC-contaminated ground waters in two existing onsite air strippers and discharging the treated effluent to the POTW for secondary treatment, the selected remedy addresses the principal threat of future direct contact/ingestion of contaminated ground waters posed by the site through the use of treatment technologies. Therefore, the statutory preference for remedies that employ treatment as a principal element is satisfied.

APPENDICES

APPENDIX A

NUMERICAL VALUES OF CONTAMINANT-SPECIFIC ARARS FOR COMPOUNDS DETECTED IN GROUNDWATER

Contaminant	SDWA MCL mg/l	SDWA MCLG mg/l	EPA SMCL mg/l	MISSOURI MCL mg/l	MISSOURI SMCL mg/l	STATE OF MISSOURI[g] WATER QUALITY STANDARDS I mg/l	VI mg/l	VII mg/l	EPA AMBIENT WATER QUALITY CRITERIA For Toxic Protection Ingesting Water and Organisms mg/l	Ingesting Organisms Only mg/l	For Carci Protection[c] Ingesting Water and Organisms mg/l	Ingesting Organisms Only mg/l	EPA AMBIENT WATER QUALITY CRITERIA FOR PROTECTION OF FRESH-WATER AQUATIC LIFE Acute mg/l	Chronic mg/l
ORGANICS														
Acrolein				0.005			0.32	0.32	0.38	0.78			0.068[b]	0.021[b]
Benzene	0.005	0					0.00068	0.00068			0.00068	0.04	5.3[b]	
Bis(2-Ethylhexyl)phthalate									15	50			0.94[b]	0.003
Butyl Benzyl Phthalate													3.3	0.22
Chlorobenzene		0.06[a]					0.02	0.02	0.488	15.05			19.5[b]	
Chloroethane														
Chloroform	0.1[a]										0.00019	0.0157	28.9[b]	1.24[b]
1,1-Dichloroethane	0.005[a]						0.00094	0.00094						
1,1-Dichloroethene	0.007	0.007		0.007			0.07				0.000033	0.00185	11.6[b]	
1,2-Dichloroethane	0.005	0		0.005			0.00094	0.00094			0.00094	0.243	118[b]	20[b]
1,2-Dichloroethylene														
1,2-Dichloropropane	0[a]	0.005	0.03[a]										23[b]	5.7[b]
1,3-Dichloropropylene							0.087	0.087	0.0141	0.087			6.06[b]	0.244[b]
Ethylbenzene	0.7[a]	0.7[a]	0.03[a]			0.32					1.4	3.28	32[b]	
Isophorone							5.2	5.2						
Methyl Chloride													550[b]	
Methylene Chloride							0.00019	0.00019	0.00019	0.0157			193[b]	
Phenol						0.1	0.1	0.3	3.5	769			10.2	2.56
Tetrachloroethene	0.005	0[a]					0.0008	0.0008			0.0008	0.00885	5.28[b]	0.84[b]
Toluene	2[a]	2[a]							14.3	424			17.5[b]	
Trans-1,2-Dichloroethene		0.07							0.033	0.00185			11.6[b]	
1,1,1-Trichloroethane	0.2	0.2		0.2			0.2		0.0184	0.00103			18[b]	
Trichloroethene	0.005	0		0.005			0.0027	0.0027			0.0027	0.0807	45[b]	21.9
1,1,2-Trichloroethane											0.006	0.0418		
Vinyl Chloride	0.002	0		0.002			0.002	0.002	0.002	0.525				

NUMERICAL VALUES OF CONTAMINANT-SPECIFIC ARARS FOR COMPOUNDS DETECTED IN GROUNDWATER

Contaminant	SDWA MCL mg/l	SDWA MCLG mg/l	EPA SMCL mg/l	MISSOURI MCL mg/l	MISSOURI SMCL mg/l	STATE OF MISSOURI[g] WATER QUALITY STANDARDS I mg/l	VI mg/l	VII mg/l	EPA AMBIENT WATER QUALITY CRITERIA For Toxic Protection Ingesting Water and Organisms mg/l	Ingesting Organisms Only mg/l	For Carci Protection[c] Ingesting Water and Organisms mg/l	Ingesting Organisms Only mg/l	EPA AMBIENT WATER QUALITY CRITERIA FOR PROTECTION OF FRESH-WATER AQUATIC LIFE Acute mg/l	Chronic mg/l
METALS														
Cadmium	0.01	0.005[a]		0.01		0.0012	0.0012	0.001	0.01				0.0018	0.0066
Chromium	0.05	0.1[a]		0.05		0.05	0.05	0.05	0.05				0.016	0.0011
Copper	0.05	1.3[a]			1	0.02[e]	0.02[e]	1					0.018[d]	0.012[d]
Lead	0.05	0.02[a]		0.05		0.05	0.05	0.05	0.05				0.082[d]	0.0032[d]
Mercury	0.002	0.002[a]		0.002		0.0005[f]	0.0005	0.002	0.000144	0.000146			0.0024	0.0012
Nickel						0.1	0.1	0.2	0.0134	0.1			1.1	0.056
Zinc			5			0.1	2	0.1					0.16	0.047
PESTICIDES AND PCBS														
PCB-1254	0.5[a]	0[a]												

Notes:

Blanks indicate data is not available

a Proposed value

b Insufficient data to develop criteria. Value listed is the Lowest Observed Effect Level (L O E L)

c The criterion for carcinogens is zero, the criterion given corresponds to an excess carcinogen risk of 1 x 10-6

d Hardness dependent criteria. Value listed is based on hardness of 100 mg/l

e Dissolved

f Total recoverable

g I - Protection of aquatic life
VI - Groundwater with known surface water recharge
VII - Groundwater with no known surface water recharge

APPENDIX B

SUMMARY OF CHEMICALS DETECTED

Constituent Detected	Maximum Reported Concentration (1): Ground Water (mg/L)	Soil (mg/kg)	POTW Effluent/ Surface Water (mg/L)	Federal MCL	EPA Weight of Evidence	Oral RfD (mg/kg/day)	RfD Water Limit (mg/L)	Overall Hazard Analysis(5)	Potential Cancer Risk(2)	Potential Hazard Index(3)
Metals										
Cadmium	.021	--	--	.010	B1(4)	.0005	.018	Low	NC	1.2
Chromium	.19	--	--	0.05	A(4)	1.0	40	Low	NC	1.0
Copper	.055	--	--	1.0	D	.037	1.3	Low	NC	.04
Lead	.007	--	--	0.05	D	.0014	.05	Low	NC	.14
Mercury	.0002	--	--	0.002	D	.0014	.07	Low	NC	.001
Nickel	.08	--	--	--	A	.02	.5	Low	NC	.11
Zinc	3.77	--	--	5.0	D	.21	7.4	Low	NC	.51
Volatile Organic Chemicals										
Acrolein	.043	--	--	--	D	NA	NA	Low	NC	NA
Benzene	.0048	.46	--	.005	A	.052	.00122	Low	$3.9X10^{-6}$	.0026
Chlorobenzene	.011	--	--	--	D	.03	1	Low	NC	.01
Chloroethane	6.3	--	--	--	D	NA	NA	Low	NC	NA
Chloroform	.012	.011	.160	--	B2	.02	.4	Low	$2.1X10^{-6}$	.017
1,1-Dichloroethane	.890	.020	.0049	--	B2	.12	4.2	Moderate	$2.3X10^{-3}$	.21
1,2-Dichloroethane	.044	--	-	.005	B2	.074	2.6	Low	$1.1X10^{-4}$	.31
1,1-Dichloroethene	1.0	11.0	.0027	.007	C	.009	.3	Moderate	$1.7X10^{-2}$	3.2
1,2-Dichloropropane	.004	--	--	--	D	.088	3.1	Low	NC	.001
1,3-Dichloropropylene	.0071	--	.0052	--	B2	.0003	.01	Low	$3.6X10^{-5}$	.67
Ethylbenzene	.016	.0026	.0061	--	D	.097	4	Low	NC	.065
Methylchloride	.027	--	--	--	D	.01	4	Low	NC	.14
Methylene chloride	3.6	2.7	0.15	--	B2	.06	2	Moderate	$7.7X10^{-4}$	1.71
Tetrachloroethene	.180	.069	--	--	B2	.02	0.7	Low	$2.6X10^{-4}$	.25
Toluene	1.5	.0078	.074	--	D	.3	10	Low	NC	.14
Trans-1,2-Dichloroethene	3.1	0.18	.310	--	D	.01	.35	Moderate	NC	2.5
1,1,1-Trichloroethane	14.0	.110	.060	0.2	D	.09	3	Moderate	NC	4.4
1,1,2-Trichloroethane	.076	.0057	--	--	C	.2	7	Low	$1.2X10^{-4}$	0.01
Trichloroethene	290.0	4.2	.180	.005	B2	.00735	.25	High	$9.1X10^{-2}$	1127
Vinyl chloride	.410	.0037	--	.002	A	.0013	.05	Moderate	$2.7X10^{-2}$	0.09
1,2-Dichloroethene	.058	--	--		B2	.01	.35	Low	--	.13
Acetone	.081									0.231
Base Neutral/Acid Extractables										
Isophorone	.029	--	--	--	D	.2	7	Low	NC	.004
Phenol	.014	--	--	--	D	.04	1	Low	NC	.01
PCB-1254	.0067	--	--	--	B2	.000006	.00021	Low	$1.5X10^{-3}$	--
Bis(2-Ethylhexyl)-Phthalate	.820	--	--	--	B2	.02	0.7	Low	$2.0X10^{-4}$	1.17

NOTES: (1) All data was collected during remedial investigation

(2) Risk based on 365 days, 2 Liters/day, 70 year duration, adult

(3) Hazard Index based on 2 Liters/day, adult

(4) Inhalation

(5) Subjective hazard level for each chemical based on comparisons to MCLs, RfDs, and occurrence in environmental media

NC Noncarcinogen via ingestion

NA Not available

APPENDIX C

CRITERIA FOR CHARACTERIZATION OF POTENTIAL CARCINOGENIC EFFECTS FOR THE INDICATOR CHEMICALS

Chemical	Cancer Potency Factors Oral (mg/kg/day)-1	 Inhalation (mg/kg/day)-1	10^{-6} Cancer Risk (h) (mg/L)	EPA Weight of Evidence
1,1-Dichloroethane	9.1E-2 (b, j, g)	—	.0004	C
1,1-Dichloroethene	6E-1 (a)	1.2 (a)	0.033	C
Methylene chloride	7.5E-3 (a)	1.42E-2	0.005	B2 (a)
Trichloroethene	1.1E-2 (a)	4.6E-3 (b,c,e)	2.7	B2 (a)
Vinyl chloride	2.3 (c,d)	2.95E-1 (b)	.00015	A (c)

(a) EPA 1987c
(b) EPA 1987e
(c) EPA 1986a
(d) EPA 1984c
(e) EPA 1984d
(f) The oral cancer potency factor for 1,1-dichloroethane is based on structure-activity relationships to 1,2-dichloroethane (EPA 1988a).
(g) EPA 1988a
(h) Concentration would probably result in 1 additional cancer in 1,000,000 population drinking 2 liters of water per day over a 70-year lifetime.

CRITERIA FOR CHARACTERIZATION OF POTENTIAL NONCARCINOGENIC EFFECTS FOR THE INDICATOR CHEMICALS

Chemical	RfD (mg/kg/day) Oral	(source)	RfD (mg/kg/day) Inhalation	(source)
1,1-Dichloroethane	1.2E-1[a]	EPA 1988a	1.38 E-1	EPA 1986a
1,1-Dichloroethene	9.0E-1	EPA 1987d	—	
Trans-1,2-Dichloroethene	1.0E-2	EPA 1987g	—	
Methylene chloride	6.0E-2	EPA 1987d	—	
1,1,1-Trichloroethane	9.0E-2	EPA 1987i	3.0E-1	EPA 1986a
Trichloroethene	7.35E-3	EPA 1987e	—	
Vinyl chloride	1.3E-1	EPA 1987a	—	

--- Not available

a Abbreviation for scientific notation: 1.2E-1 = 1.2×10^{-1}

APPENDIX D

POTENTIAL HUMAN HEALTH RISK SUMMARY (CURRENT CONDITIONS)

Exposure Scenario	Adult	Child	Infant
Dermal Contact/Ingestion Off-Site Subsurface Soil			
Cancer Risk	1.1×10^{-8}	2.9×10^{-9}	2.0×10^{-10}
Noncarcinogenic Risk	0.001	0.001	0.0004
Dermal Contact/Ingestion Subsurface Soils on Main Street			
Cancer Risk	2.9×10^{-8} (5.6×10^{-8})*	–	–
Noncarcinogenic Risk	0.012 (0.021)*	–	–
Dermal Contact with Surface Water from POTW			
Cancer Risk	$<1.0 \times 10^{-10}$	$<1.0 \times 10^{-10}$	–
Noncarcinogenic Risk	<0.00	<0.00	–
Dermal Contact with Surface Water from Utility (POTW Influent)			
Cancer Risk	$<1.0 \times 10^{-10}$	–	–
Noncarcinogenic Risk	<0.00	–	–
Dermal Contact with Surface Water from Utility (Away from Main Street)			
Cancer Risk	$<1.0 \times 10^{-10}$	–	–
Noncarcinogenic Risk	<0.00	–	–
Dermal Contact with Surface Water from Utility/Telephone Manholes			
Cancer Risk	$<1.0 \times 10^{-10}$	–	–
Noncarcinogenic Risk	<0.00	–	–
Inhalation of Airborne Chemicals from Stripping Tower			
Cancer Risk	6.5×10^{-6}	5.6×10^{-6}	1.6×10^{-6}
Noncarcinogenic Risk	0.2284	0.4010	0.3997

*Health risk levels associated with clayey soils

CUMULATIVE POTENTIAL HUMAN HEALTH RISKS FOR A MUNICIPAL SEWER WORKER LIVING NEAR THE SITE

Exposure Scenario	Cancer Risk	Noncarcinogenic Risk
Dermal Contact/ Ingestion of Off-Site Subsurface Soil	1.1×10^{-8}	0.001
Dermal Contact/ Ingestion of Subsurface Soil on Main Street	2.9×10^{-8} (5.6×10^{-8})*	0.012 (0.021)*
Inhalation of Airborne Chemicals from the Stripping Tower	2.3×10^{-6}	0.016
Total Risk	2.3×10^{-6} (2.3×10^{-6})*	0.029 (0.038)*

NOTE: * = Health risk level associated with clayey soils.

POTENTIAL HUMAN HEALTH RISK SUMMARY (FUTURE CONDITIONS)

EXPOSURE SCENARIO	ADULT	CHILD	INFANT
Dermal Contact/Ingestion On-Site Surface Soil			
Cancer Risk	3.9×10^{-8}	2.0×10^{-9}	1.0×10^{-10}
Noncarcinogenic Risk	0.0004	0.0003	0.0002
Dermal Contact/Ingestion On-Site Subsurface Soil			
Cancer Risk	5.7×10^{-8}	3.6×10^{-9}	6.0×10^{-10}
Noncarcinogenic Risk	0.149	0.124	0.062
Dermal Contact/Ingestion On-Site UFSB Ground Water			
Cancer Risk	4.6×10^{-2}	1.6×10^{-2}	2.3×10^{-3}
Noncarcinogenic Risk	191	383	335
Dermal Contact/Ingestion On-Site SBR Ground Water			
Cancer Risk	1.1×10^{-1}	3.9×10^{-2}	5.7×10^{-3}
Noncarcinogenic Risk	1146	2292	2005
Dermal Contact/Ingestion On-Site DBR Ground Water			
Cancer Risk	9.0×10^{-3}	3.0×10^{-3}	4.5×10^{-4}
Noncarcinogenic Risk	71.3	143	125
Dermal Contact/Ingestion Off-Site Main Street Area UFSB Ground Water			
Cancer Risk	3.2×10^{-3}	1.1×10^{-3}	1.6×10^{-4}
Noncarcinogenic Risk	30	61	53
Dermal Contact/Ingestion Off-Site Main Street Area SBR Ground Water			
Cancer Risk	6.6×10^{-5}	2.3×10^{-5}	3.3×10^{-6}
Noncarcinogenic Risk	0.816	1.63	1.43

POTENTIAL HUMAN HEALTH RISK SUMMARY (FUTURE CONDITIONS) (CONT'D)

EXPOSURE SCENARIO	ADULT	CHILD	INFANT
Dermal Contact/Ingestion Off-Site Main Street Area DBR Ground Water			
Cancer Risk	4.1×10^{-4}	8.2×10^{-4}	2.0×10^{-5}
Noncarcinogenic Risk	3.53	7.05	6.17
Dermal Contact/Ingestion Off-Site Away From Main Street UFSB Ground Water			
Cancer Risk	3.0×10^{-6}	1.0×10^{-6}	1.4×10^{-7}
Noncarcinogenic Risk	0.04	0.07	0.06
Dermal Contact/Ingestion Off-Site Away From Main Street SBR Ground Water			
Cancer Risk	3.9×10^{-3}	1.3×10^{-3}	1.9×10^{-4}
Noncarcinogenic Risk	0.02	0.05	0.04
Dermal Contact/Ingestion Off-Site Away From Main Street DBR Ground Water			
Cancer Risk	no carcinogens		
Noncarcinogenic Risk	no indicator chemicals		

RESPONSIVENESS SUMMARY

RECORD OF DECISION

FOR THE

SOLID STATE CIRCUITS SITE

REPUBLIC, MISSOURI

SEPTEMBER 1989

RESPONSIVENESS SUMMARY

TABLE OF CONTENTS

SOLID STATE CIRCUITS SITE
REPUBLIC, MISSOURI
RESPONSIVENESS SUMMARY

1.0 OVERVIEW

In the Proposed Plan released to the public, the Missouri Department of Natural Resources (MDNR), with EPA concurrence, made a preliminary selection for the preferred alternative. MDNR's recommended alternative addressed the ground water contamination problem at the site. The preferred alternative involved extraction and containment of the contaminant plumes using existing and new wells, treatment of the extracted water using existing onsite air strippers and discharge of the treated water to the publicly owned treatment works (POTW) for further treatment.

Judging from the comments received during the public comment period, the residents and several city aldermen of Republic, and the Greene County Commission generally did not favor the preferred alternative as presented. The Greene County Commission clearly stated that they favored the discharge option to the POTW but with a combination of Alternatives II and III, which would combine metals removal, air stripping, and carbon adsorption prior to discharge of the treated water. Republic residents and aldermen did not clearly state their preference for discharge; however, an analysis of the transcript of the public meeting generally showed that residents either wanted a new sewage treatment plant built exclusively for the SSC discharge or to use the POTW, provided the metals are removed in order to ensure there would not be a problem with disposal of the POTW sludge. POTW concerns centered around how the treatment capacity would be affected by the site discharge and whether metals would upset the balance of the POTW. One alderman asked for an analysis of what would happen to the sewage treatment plant as far as possible breakdown of the algae.

The PRPs supported the preferred alternative as described in the Proposed Plan.

2.0 BACKGROUND ON COMMUNITY INVOLVEMENT

Community interest in the Solid State Circuits Site (SSC) dates back to 1983 when residents of Republic were first notified that trichloroethene (TCE) had been detected in Municipal Well Number 1 and the distribution system. The Solid State Circuits Site is important to the 6,300 residents of Republic because of its effect on the water supply. When Well Number 1 was taken out of service, the City was forced to rely on its two remaining wells, Numbers 2 and 3. These two wells were adequate to meet daily demands, but if the larger of the two remaining wells had to be shut down, the amount pumped would be less than the average daily use. One of the town's main industries, home building, was at a standstill because there was not enough water for new subdivisions.

City officials and a number of interested citizens in the community were actively involved in seeking remedies to the situation. A special task force was formed to resolve the town's water supply problems. The town's mayor and city council members tried to put together matching money for a water grant from MDNR, but the Missouri Legislature failed to appropriate funds for the water grants program for Fiscal Year 1987. The MDNR met with city officials several times to discuss options for resolving water supply problems; however, they could not provide the city with any money.

The MDNR conducted phone and personal interviews with interested residents from February through April 1986. The key concerns identified were:

<u>Adequate Water Supply</u>

The town was concerned about having enough water since City Well Number 1 was not in use. A related concern was the fear that one of the city's other two wells might become contaminated. This would create an immediate water crisis for the town.

<u>Consumption of Contaminated Water</u>

Some residents had little faith in the monthly testing of Well Numbers 2 and 3. They believed that the water could already be contaminated, and that they could be drinking contaminated water. They doubted that anyone would really tell them if the water was contaminated.

<u>Long Term Health Effects</u>

Residents were concerned about whether they would experience any adverse health effects from the TCE found in the city's water supply. The contaminated well was shut down before levels of TCE reached unsafe levels, but nonetheless, residents wondered if they would experience long-term health problems.

<u>Spread of Contamination</u>

Some residents were concerned that continued operation of the city's other two wells might be spreading the contamination. They wondered about the present extent of contamination and the possibility that private wells might become contaminated.

Time Frame

Many citizens were concerned about the length of time it might take to get a new well and the length of time required for cleanup. They wanted to see faster progress on both issues.

Economic Impact

Water supply problems posed a big threat to the town's economic health. A moratorium on the construction of new buildings and subdivisions was in effect. Local building contractors were faced with laying off workers if the water supply problems were not resolved. This would cause the town's economic growth to come to a halt.

Responsible Party

Residents indicated they felt the responsible party should shoulder more of the burden in helping the city to resolve its water supply problems. They were concerned that the responsible party would escape some of its obligations to the community. Solid State Circuits, Inc. did contribute funds toward the construction of Municipal Well Number 4, which was brought on line in 1988. This helped alleviate some of the community's concerns about an adequate water supply, and the construction moratorium was lifted.

Lack of Information

Most people wanted to see more information available. As citizens became more knowledgeable about the site, they felt a need for more technical information. They also wanted to be updated regularly on the situation.

3.0 SUMMARY OF COMMENTS RECEIVED DURING PUBLIC COMMENT PERIOD

Comments raised during the public comment period on the draft Feasibility Study (FS) and proposed plan are summarized briefly below. The comment period was held from August 14 to September 14, 1989. The comments are categorized by relevant topics.

A. Remedial Alternative Preferences

Each of the major commentaries on the draft FS expressed a preference for specific alternatives:

1. The members of the Greene County Commission read a statement at the public meeting in support of a combination of both Alternatives II and III. Alternative II was appealing to the Commission because it affords treatment of the contaminants, and the

ultimate discharge is to the POTW. Alternative III is appealing in that it removes the metals and utilizes a process of both carbon adsorption and air stripping. The Commission wanted the combined alternatives to include the treatment of heavy metal contaminants, air stripping of the volatile organic compounds (VOCs), and carbon absorption, with the ultimate discharge from these activities being delivered to the POTW.

2. A citizen wrote a comment letter in support of Alternative III. He felt that the discharge of treated water from Alternative II would be overloading the City's sewage disposal system. He was concerned about the disposal system being unable to handle the City's residential and business waste.

3. Another citizen stated in writing that Solid State Circuits should build and operate a separate pretreatment plant to remove the solids from the water and, if Republic's sewage disposal plant can handle the extra liquid, put the water in the disposal system. He also wanted SSC to pay a higher rate than the residents of Republic to use the disposal system.

4. Solid State Circuits, Inc. wrote a comment letter in support of Alternative II for several reasons:

   a) Alternative II provides a comprehensive remediation plan and utilizes proven remediation technologies and methods;

   b) Discharge to the POTW provides a backup treatment capability, whereas Alternatives III and IV do not;

   c) During the RI/FS and Pilot Study, remediation under Alternative II has already begun and can continue without interruption, providing remediation as opposed to more study and delay that would result from selection of Alternatives III or IV.

   d) Selection of Alternative II will result in little or no disruption to the citizens and streets of the City of Republic, since a discharge line from City Well Number 1 to the Main Street sewer line was completed earlier this year. Selection of Alternative III would require a dedicated discharge line constructed through the heart of the city. This would be very disruptive to the citizens and to traffic flow;

e) Alternative II will generate approximately $90,000 per year to the City of Republic (based on a charge of $1.25 per 1000 gallons and a discharge of 150 gpm). Black & Veatch Engineers, an engineering consulting firm, has estimated that the operation and maintenance costs at the flow through portions of the Republic POTW system to be $0.5416 per 1000 gallons and a capital allocation for the Treatment Plant of $0.1743. This results in a combined cost to the City of Republic of $0.7159, with estimated income to Republic of $0.5341 per 1000 gallons. These allocations and estimates were based on the Republic User Charge Ordinance No-84-1007. If Alternatives III or IV are selected, very little, if any, money would be paid to the Republic POTW since the system would be bypassed after implementation of the final remedy;

f) SSC and the City of Republic have entered into an agreement that allows SSC to discharge treated effluent from the site (up to 200 gpm) to the sewer system and provides that SSC will reimburse the City of Republic for any increase in actual charges paid by the city for disposal of sludge from the POTW. This agreement was originally agreed to in late 1986 and was recently amended by unanimous vote of the City Board of Aldermen on June 12, 1989;

g) Implementation of Alternative II will <u>not</u> impact the City of Republic's POTW ability to treat suspended solids and/or impact the biological oxygen demand since there will be no discharge of "sewage" from the site; and,

h) Alternative II is more cost effective and best achieves the goals of the National Contingency Plan.

<u>MDNR/EPA Response:</u>

The agencies previously considered the need for metals removal and carbon absorption for Alternative II and the impact of Alternative II on the treatment plant. The responses are given in the following subsection entitled "Technical Question/Concerns Regarding Remedial Alternatives;" specifically, Question Numbers 1, 2, and 4. In summary, metals removal or carbon adsorption is not needed for Alternative II. The SSC discharge will not add to the treatment capacity load on the POTW, since the discharge will have no significant organic and solids load associated with it. The comments received orally and in writing did not cause MDNR or EPA to alter their technical decisions about the site. The public did have valid concerns and comments, but they were issues which had been previously considered by both agencies.

Response to the PRPs comment letter:

a) Alternative III uses metals removal and carbon adsorption, which are both proven technologies. Alternative IV uses carbon adsorption and reinjection of the treated effluent to the deep bedrock aquifer as part of an enhanced ground water contaminant recovery system. Enhanced ground water contaminant recovery has not been widely used in the state as a means of plume management;

b) Carbon adsorption provides the secondary treatment for Alternatives III and IV;

c) Remediation can be started quicker with Alternative II, since most of the remedial components are already in place. Alternative III will require onsite construction of the metals removal unit and the carbon adsorption unit and construction of the two mile long discharge pipeline to Shuyler Creek. Alternative IV will require onsite construction of the carbon adsorption unit and offsite construction of the reinjection wells. Additionally, more time will be needed to determine the most effective locations of the reinjection wells;

d) Implementation of Alternative II will require the construction of four new offsite extraction wells and pipelines from offsite wells to carry the extracted water back to the air strippers, but this same construction is also required for Alternatives III and IV. This construction will not disturb the community as much as construction of Alternative III's two-mile pipeline or Alternative IV's reinjection wells; and,

e-h) MDNR/EPA have no specific responses to these comments.

B. Technical Questions/Concerns Regarding Remedial Alternatives

<u>Question 1.</u>

There were several questions asking why metals removal was a part of Alternative III but not Alternative II, and what effect metals, particularly copper, would have on the POTW.

Additionally, Solid State Circuits, Inc. had the following comment in their written comment letter regarding metals removal.

> "Metals removal from the effluent would require implementation of a treatment technology (metals precipitation) that is unnecessary and impractical for this site. It is very likely there would be no reduction in the metals' levels and would potentially create an air emissions problem and generate sludge that would have to be stored, transported and disposed at an approved facility. This type of approach is inconsistent with the long-term environmental policy of the EPA and the State of Missouri. It is unreasonable and not practical to implement a metals removal system to reduce copper levels from 55 ug/l to below 29 ug/l. These levels already approximate the levels permitted under the Safe Drinking Water Act Maximum Contaminant Level of 50 ug/l and a proposed Maximum Contaminant Level Goal of 1,300 ug/l. As a point of fact, the Southwest Treatment plant of the City of Springfield allows industrial users to discharge over 2,000 ug/l of copper to the sewer with no adverse impact on Springfield's POTW."

<u>MDNR/EPA Response:</u>

Table 4-3 of the Remedial Investigation (RI) Report (pages 4-9) presents the detected maximum, detected minimum, and detected average of metals in ground water samples. Part of that table is reproduced below. The metals reportedly in the SSC waste stream at the time of operation were chromium, copper, iron, manganese, and zinc.

Metals (ug/l)	Maximum	Minimum	Average	No.Detected/ No. Sampled
Chromium	190.0	190.0	190.0	(1/35)
Copper	55.0	5.	19.3	(15/54)
Zinc	3770.0	10.0	490.6	(18/83)
Iron	47700.0	60.0	5300.0	(39/91)
Manganese	32900.0	20.0	5230.0	(22/48)

Chromium was detected only once in thirty-five samples, and subsequent sampling of the location with the 190 ug/l concentration produced nondetectable concentrations. The only samples with detectable levels of copper were municipal water supply wells, not onsite wells. Copper is endemic to municipal water supplies because of all the copper fittings, pipes, impellers, etc., which are used in the distribution system. Additionally, many residential homes have copper water pipes, which contribute copper to the water. Zinc is present at elevated levels onsite. Iron and manganese occur naturally in ground water, so the higher iron and manganese levels may not be attributable to the site.

The 1987 Census of Missouri Public Water Supplies, Chemical Water Quality Section, shows that the Republic's public water supply had iron present at less than 100 ug/l and manganese at less than 20 ug/l. However, these concentrations were from drinking supply wells, which were designed, installed and developed differently from monitoring wells such as the ones used in the RI. Properly installed drinking supply wells effectively screen metals from entering the drinking water supply. Thus, the 1987 Census levels are not an appropriate indicator of actual iron and manganese in the aquifer.

For Alternative II, a metals removal step is not required for several reasons:

(a) The metal concentrations are far below the appropriate pretreatment standards. The following pretreatment standards apply to electroplating and metal finishing industries (EPA Guidance Manual for Electroplating and Metal Finishing Pretreatment Standards, February 1984) and are metal levels which these industries attempt to achieve using metals removal systems before discharging to a POTW:

Metals (ug/l)	Pretreatment Standard
Chromium	1,710
Copper	2,070
Zinc	1,480
Iron	-
Manganese	-

Pretreatment standards for iron and manganese do not exist and, thus, are not enforceable;

(b) The POTW should remove up to fifty percent (50%) of the metals in the waste stream before discharging to Dry Branch;

(c) Discharge to the sewer will reduce the concentrations due to dilution to approximately twenty-five percent (25%) of the original site concentrations. This factor, in addition to, (b) will reduce the known metal concentrations presented in the first table to below stringent aquatic-life criteria which are presented later in this response; and,

(d) The NPDES effluent requirements for the Republic POTW do not include criteria for the metals of discussion.

Concerns were voiced in the public meeting regarding the effects that the metal levels will have on the POTW, particularly copper. For an activated sludge based POTW such as Republic's, the following inhibition levels are presented for the metals of concern (EPA Guidance Manual on the Development and Implementation of Local Discharge Limitations Under the Pretreatment Program, December 1987):

Metals (ug/l)	Inhibition Level
Chromium	1,000 - 100,000
Copper	1,000
Zinc	5,000 - 10,000
Iron	-
Manganese	-

Again, the metals concentrations in the SSC discharge are far below these limitations. Eighty percent (80%) of the site pumping will come from the same deep aquifer which the city draws its water supply. Thus, in terms of metals, the site's discharge will closely resemble the water currently treated by the POTW. Additionally, the POTW has not experienced an "upset" during the pilot study or during the extended pumping of City Well Number 1. Both of these activities discharged significant volumes of water to the POTW similar to what is expected in the SSC waste stream.

Alternative III includes a metals removal option; because, it is anticipated that the direct discharge to Shuyler Creek will need to meet stringent discharge limits for metals. The exact limits and parameters will not be known until the application is submitted to the MDNR for evaluation, but generally, for a low-flow stream, like Shuyler Creek, which provides little dilution, the permit limits will be at or slightly higher than the Missouri water quality standards for aquatic life protection. Enclosed is a copy of these standards. The aquatic life protection numbers are shown in Column I. Assuming no dilution by the creek and further assuming that chronic toxicity values, general warm water fishery values, and a hardness category of 125-200 mg/l will be used, the NPDES permit limits could be very similar to the following values:

Metal	Level (ug/l)
Chromium	42
Copper	29
Iron	1,000
Manganese	Value to be determined by MDNR
Zinc	345

If the receiving stream provides significant dilution, the metals' limits could be higher than the values given as examples. Also, the naturally occurring level of metals in the receiving stream will be considered when selecting the metals' parameters and limits for the NPDES permit.

For Alternative IV, the reinjection of treated water as part of an enhanced ground water contaminant recovery to the deep bedrock aquifer will need to meet the Missouri water quality standards established for ground water which does not recharge surface water. These standards are shown in Column VII of the enclosed regulation. The values are:

Metal	Level (ug/l)
Chromium	50
Copper	1,000
Zinc	2,000
Iron	300
Manganese	50

It is unlikely that the chromium value will be above 50 ug/1, since the 190 ug/1 concentration was only detected in one out of 35 samples. The iron and manganese values in the treated water may require metal removal if the levels are significantly above naturally occurring background levels before the treated water can be reinjected as part of an enhanced ground water contaminant recovery.

Question 2.

The majority of questions asked in the public meeting concerned how the increased flow from the SSC site would affect the treatment capacity of the Publicly Owned Treatment Works (POTW). Many residents and city officials felt the site discharge was shortening the projected life of the POTW.

MDNR/EPA Response:

The Republic POTW has a design flow (treatment capacity) of 926,880 gallons per day (gpd) and a peak flow (hydraulic capacity) of 7.34 million gallons per day (mgd). The hydraulic capacity was set to accommodate flows caused by known infiltration and inflow problems of the sewer system. More importantly, the treatment capacity is the flow which the POTW is designed to treat within discharge criteria set by the State in the NPDES permit. The treatment capacity is based upon the following two design parameters: organic load and solids load.

Alternative II involves discharging treated ground water from the SSC site to the sewer. The organic and solids load associated with this discharge water is essentially zero. The

SSC discharge water is similar to plain water in total organic and solids load, and very unlike the sewer discharge coming from domestic and commercial sources. In other words, the SSC discharge will not add to the treatment capacity load on the POTW.

With the high hydraulic capacity, the plant can accept an actual flow larger than the treatment capacity without upsetting operations as long as the organic and solids loads are not surpassed, and the plant's operational procedures are modified to meet NPDES effluent criteria. The SSC discharge (216,000 gpd) will increase the total flow to the POTW by twenty-nine percent (29%) or a total flow of approximately 966,000 gpd (based on current POTW usage of 750,000 gpd). This flow increase may require an adjustment to the current POTW operating procedures. Adjusting operating procedures is considered normal practice as the actual flow changes during the life of a POTW.

The Republic POTW was built with EPA and MDNR oversight and financing through the EPA Construction Grants Program. POTWs built through this program were very conservatively designed to keep operator oversight requirements to a minimum. Consequently, the treatment capacity was typically rated lower than the plant could handle if operated differently. Specifically for the Republic POTW, the aerator is the limiting unit in determining the treatment capacity. The retention time for sewer water in the brush aerator unit was designed to be 23.8 hours. Reducing the retention time increases the flow through the aerator and increases the treatment capacity as long as the flow receives adequate treatment. Design and field experience has shown that this type of aerator provides adequate treatment for a retention time as low as eight (8) hours.

Computer modelling was conducted to evaluate the performance of the Republic POTW given the designed organic and solids loads at several different total flows, including a total flow of 1.46 mgd. The 1.46 mgd modelled flow consisted of 0.8 mgd contributing organic and solid loads per designed rates and 0.66 mgd contributing zero organic and solids loads. The modelling results indicate that all NPDES effluent criteria would be met satisfactorily with modification to the POTW's operating procedure by reducing the aerator retention time to sixteen (16) hours. This modification can be done without capital improvements.

The Wastewater Facilities Plan for Green County (1984) projects a year 2025 population of 13,776. Based on this projection, the POTW will reach the design organic and solid loading capacities sometime between the year 2005 and 2015, depending whether the actual population loading contribution is high or average. Actual Republic POTW data logs were evaluated for the ten-month period between September 1986 and June 1987. Actual organic and solids loads during that time period averaged approximately seventeen percent (17%) and forty-one percent (41%) below the designed treatment organic and solids loads, respectively.

Question 3.

One alderman questioned the wording in the Proposed Plan regarding the alternatives. Alternative III says the contaminants will be permanently removed, and Alternative IV says the contaminants will be permanently and irreversibly removed. Alternative II does not say anything about whether the contaminants will be permanently or irreversibly removed. Why?

MDNR/EPA Response:

This is simply an oversight in wording. The exact page in the Proposed Plan reviewed by the alderman was not cited, but there are other references in the feasibility study which have wording to this effect. In Section 6.2 of the Feasibility Study on page 6-20, the second paragraph states "Under Alternatives II, III, and IV, contamination levels in the ground water in all three systems would be irreversibly reduced to acceptable levels with no remaining risks." On page 6-3, the paragraph above section 6.4 states that "Alternatives II, III, and IV would all be protective of human health and the environment by extracting and treating the contaminated ground water. . . .the contaminants would be permanently removed from the ground water." We believe that Alternatives II, III, and IV will permanently and irreversibly remove contaminants from the ground water equally, regardless of the differences in text wording of the Proposed Plan. Any omissions in the wording of Alternative II were unintentional.

Question 4.

Several residents wanted the cleanest water possible discharged to the POTW. They wanted metals removal, air stripping, and carbon adsorption of the extracted water prior to discharging it to the POTW.

MDNR/EPA Response:

A POTW is designed to process a city's domestic and industrial waste to produce an acceptable effluent. Its purpose is not to handle the cleanest water possible. Often times, industrial waste requires pretreatment before discharge to the sewer. Calculations indicate that Republic's POTW can reduce up to 200 micrograms per liter (ug/l) TCE to meet its NPDES discharge limit of 2 ug/l. Pretreatment standards for the SSC discharge were established at 200 gallons per minute (gpm) and 200 ug/l.

SSC discharged treated water from the air strippers periodically during the remedial investigation. SSC has sampled the POTW effluent during these discharges, and the POTW limit of 2 ug/l was only exceeded once. An evaluation of this excursion did not link it to the treated water discharged from the air strippers. Additionally, City Well Number 1 has been pumped and discharged almost continuously to the sewer without treatment since the levels of TCE have been consistently below 200 ug/l. SSC sampled the POTW influent and effluent twice a month, and the NPDES permit limit has not been exceeded. Thus, Alternative II does not require carbon adsorption.

A metals removal step is not required for Alternative II due to two reasons: 1) the Republic POTW's NPDES permit does not include limits on the metals in question; and, 2) as explained in question Number 1, dilution in the sewer, POTW metals removal, and 80 percent pumping from the deep aquifer will produce a POTW effluent which is anticipated to meet applicable regulations or relevant pretreatment standards. MDNR's water pollution control program concurred with these statements.

The suggestion was made to combine elements of Alternatives II and III, in which there would be metals removal, air stripping and carbon adsorption of the extracted water prior to discharging it to the POTW. As the discussion above shows, such pretreatments are unnecessary for discharge into the POTW.

Further, it is not cost effective to provide such treatments, basically to the standard for discharge into Schuyler Creek under a NPDES permit, and in addition pay the substantial amounts in user fees that would be required for use of the POTW. In other words, Alternatives II and III are mutually exclusive, and a combination of the two would result in duplicative treatments and costs for the remediation.

Question 5.

A question was asked about the frequency of monitoring and how long it takes to get sampling results back. What if the TCE concentration exceeds 200 ug/l and it takes a while before the TCE exceedance is discovered? What will happen to the POTW?

MDNR/EPA Response:

The POTW has been sampled twice a month during the RI/FS. A monitoring frequency has not yet been established for RD/RA; however, the feasibility study proposes a frequency of once a week. The normal time required to get volatile organic sample results back from the laboratory ranges from two to three weeks. It is possible that a TCE exceedance may not be detected for three weeks. However, wastewater treatment plants have a large buffering capacity to protect the treatment facility and the environment from unexpected shock loads of harmful materials.

The NPDES permit requires that the TCE effluent concentration achieve a monthly average of 2 ug/l and that it be measured once every six months. SSC is already sampling the POTW twice a month.

A review of the treated effluent from Stripper Tower 2 (pages 4-122 of the RI report) shows that from September 21, 1987 to December 23, 1988, the TCE level in the treated effluent prior to discharge to the POTW ranged from nondetect (2.0 ug/l) to 26 ug/l. Prior to September 21, 1987, there were two results which exceeded 200 ppb. These occurred during startup of the stripping tower system when the process was not optimized. The air strippers have proven that they can consistently achieve low TCE concentrations well below 200 ppb. Additionally, as the remediation progresses, the levels of VOCs in the ground water will continually decrease so the air stripper effluent will have even lower levels of VOCs.

If the efficiency of the air stripping towers was not known, more frequent monitoring of the effluent would be warranted. However, considerable data shows that the air strippers are performing at the level for which they were designed. Unless there are significant design changes, which adversely affect the stripping efficiency of the towers, sampling for the stripper tower effluent will not be required more frequently than twice a month.

There will be four new unconsolidated/fractured shallow bedrock extraction wells constructed in the plume along Main Street to Highway 60. The feasibility study proposes that two of these wells may be discharged directly to the sewer system, if the level of TCE is below 200 ug/l. These new discharge points will require frequent monitoring, at first, until the Agencies are satisfied that the levels consistently remain below 200 ug/l.

Question 6.

One alderman commented that Alternative III, which features metals removal, will produce a metals sludge residual requiring offsite disposal at an approved waste disposal facility. This would be giving a part of Republic's problem to someone else. The alderman commented that Republic should deal with its own waste.

MDNR/EPA Response:

We agree with this comment. Alternative III is not as desirable a remedy; because, it produces the metals residual, whereas Alternative II will produce no residuals. Also, Alternatives III and IV will both produce a spent carbon residual which will need to be regenerated (heated at high temperatures) to destroy the volatile organics removed by the carbon.

Question 7.

A question was asked about the ground water movement. Will the contaminated plume enter a large underground cavern and disappear?

MDNR/EPA Response:

The immediate site area is not highly karst. Extensive geophysical surveys (a very low frequency survey and a shallow seismic survey) were conducted to determine underground features. A bedrock low was identified along Main Street, which is providing a pathway for the TCE migration along Main Street toward Highway 60. There is a normal amount of fracturing in the upper part of the shallow bedrock system where it meets the unconsolidated system, but there were no large fractures or caverns identified through which the contaminated plumes will disappear.

Question 8.

Several residents asked how much testing has been done to determine the spread of contaminants to surrounding surface areas.

MDNR/EPA Response:

A total of 15 pre-RI background surface soil samples was collected by MDNR and the EPA to help characterize the soil chemistry near and around the site. Samples were analyzed for volatile organic compounds or TCE. With the exception of two MDNR samples, the laboratory analytical data showed that VOCs were not present in any offsite soil samples. MDNR analytical reports indicate the only compound detected in the two MDNR samples was TCE at 2.0 and 270 ug/kg in samples collected from a garden area at 230 S. Main Street and the ditch on the east side of Main Street at 230 S. Main Street, respectively. The 2.0 ug/kg TCE detected in the garden soil sample is below levels of concern, and the 270 ug/kg TCE reported for the ditch sample was determined by MDNR to be a laboratory error.

During the RI, a total of 54 offsite subsurface (greater than 12 inches in depth) soil samples were collected from soil borings during shallow unconsolidated zone monitoring well construction. TCE concentrations were consistently less than 10 ug/kg at depths less than approximately 15 feet below the land surface. The maximum TCE concentrations, up to 340 ug/kg, are found at depths greater than 15 feet below land surface and are primarily confined to the two to three foot zone above the top of the bedrock. The VOCs in ground water are the source for the VOCs found in the soils.

Question 9.

One resident asked about the health risks to citizens living in a three-block radius due to the movement of shallow ground water into basements or the movement of surface water on lawns, gardens, and ditches.

MDNR/EPA Response:

Solid State Circuits, at the request of MDNR and EPA, sampled air in a storm cellar, a partial basement, a crawl space, and a full basement along Main Street south of the site. The results of these air samples showed that the volatile organic compounds have not entered these below grade structures. Surface water runoff from the site should not be a problem, since no surface soil contamination remains onsite. As discussed in the previous question, no offsite surface soil contamination was found. Additionally, no surface water contamination was discovered. Robert's Spring in Shuyler Creek was sampled. No constituents related to the SSC site were found in surface water samples.

Question 10.

One alderman questioned if it was our intent to increase pumping to 1,000 gpm, if any POTW study had taken that into consideration and will we increase the rate without the City's knowledge?

MDNR/EPA Response:

The pumping rate will not be increased to 1,000 gpm. This pumping rate was evaluated earlier in the feasibility study process. There were some alternatives which evaluated using existing wells REM-1 and CW-1 and a new deep bedrock well. These wells would be pumped on an expedited schedule so that all contamination in the aquifer would be removed in 5 to 10 years. The total required flow rate for all wells would be approximately 1,000 gpm. This combined pumping rate was selected because it would not adversely affect water levels in the City of Republic's municipal wells. These expedited alternatives were rejected because the adequate city water supply did not justify the cost of an expedited cleanup. Additionally, there were no increased health benefits from an expedited cleanup because no one is presently exposed to contaminated ground water either through direct contact or ingestion.

Question 11.

Several residents asked if we could guarantee rural wells around Republic free from TCE from this site if they were at least 300 feet deep. Do rural residents need to have their wells tested, and who is going to pay for the testing?

MDNR/EPA Response:

There are no guarantees. Based on what is presently known about the extent of contamination, the rural wells should not be affected by the site. The plumes in the deep bedrock and the shallow bedrock aquifers extend no further south from the site than City Well Number 1, and the unconsolidated plume is confined to a narrow band along Main Street, which extends south to Highway 60. Republic's other municipal wells have been sampled on a monthly basis, and no contamination has been detected in these wells. The Missouri Department of Health has sample selected rural wells within one and a half mile south and east of the site, and no contamination has been detected. We do not feel there is a need for rural residents to have their wells sampled. Rural residents may want to have their wells sampled for their own reassurance, but this expense must be borne by the well owner.

Question 12.

One alderman asked if this problem reaches well Number 2 in 13 years, could we expect SSC to build the city a new well. Why should the city keep closing wells with no replacements?

MDNR/EPA Response:

Ground water modelling has been used to show that onsite pumpage will control the spread of contamination to prevent Municipal Well Number 2 from becoming contaminated. The proposed rate of 150 gpm is more than adequate to control the plume. It is only in the absence of onsite pumping that the plume will migrate. The selected remedy will utilize onsite pumping to draw the contaminants back toward the site so they can be withdrawn with the extraction wells and treated by air stripping. The contaminants will be removed from the ground water, and in time the levels will be reduced to safe drinking water levels. Municipal Well Number 1 can then be placed back in service if this is what the City of Republic wants to do.

Question 13.

One citizen asked, "What proof do we have that the air stripping process is a safe process? How do we know that we won't be exposed to airborne TCE instead of exposure through the water supply? Will there be an ambient air monitoring program?"

MDNR/EPA Response:

The Industrial Source Complex Long Term (ISCLT) model was used to estimate probable annual emission rates from the air stripping tower operation. The ISCLT model is an air dispersion model that solves for the distribution of chemicals in the air. The model uses historic meteorological data for the area of interest and site specific chemical data to estimate potential contaminant concentrations at predicted locations of maximum effect. In January 1988, a three-week aquifer test was conducted at the site in which the contaminated ground water was pumped from the bedrock units with onsite wells and treated through the air stripper system. Chemical data was collected from the stripper tower influent during the aquifer test, and the removal efficiency of the stripper towers was calculated. Based on stripper tower VOC removal efficiencies calculated during the aquifer test, a mass emission rate for each compound was calculated. The meteorological data from Springfield, Missouri and emission rates calculated from the onsite aquifer test were used in the ISCLT modeling effort. The model evaluated two tower heights and three different flow rates. The simulation runs for the lowest tower height and the highest flow rate (150 gpm) represented the highest emission rates. The highest rates were used to determine health risks associated with the stripper tower emissions. The noncarcinogenic risks from inhalation exposure were 0.0782, 0.2284, and 0.3997 for an adult, child, and infant, respectively. An acceptable noncarcinogenic risk is 1.0 or less. The carcinogenic risks were 6.5×10^{-6}, 5.7×10^{-6}, and 1.6×10^{-6} for an adult, child, and infant, respectively. The acceptable carcinogenic risk range is from 1×10^{-4} to 1×10^{-7}. The health risk calculations indicate that the long-term exposure to stripper tower emissions does not pose unacceptable public health risks.

The need for an ambient air monitoring program will be evaluated during remedial design.

Question 14.

One citizen asked, that if this situation is not handled perfectly, who will pay 20 years down the road when law suits for cancerous situations occur for citizens of Republic?

MDNR/EPA RESPONSE:

Presently, there is no unacceptable health-based exposure to the public. During the remedial action, it is anticipated there will be no unacceptable, health-based exposure to the public. These statements are supported by extensive sampling in the past and planned sampling in the future.

Also, the responsible parties will never be relieved of their legal liability associated with the release of the contaminants.

Question 15.

Two people asked how safe is the drinking water at the present time. What steps are taken to ensure the ground water contamination does not seep into the water pipes which service the homes? How secure is the water system? How old are the water pipes?

MDNR/EPA Response:

The MDNR has sampled the other three municipal wells (2, 3, and 4) on a monthly basis. To date, we have detected no contamination in these well samples. In October 1988, we did detect 1,1,1-trichloroethane (TCA) at 5.1 ug/l in a sample taken from Municipal Well No. 2; however, the contaminant has not been detected since or prior to the October 1988 sample. The minimum quantity of 1,1,1-TCA, which can be detected with the analytical method is 5.0 ug/l. The detected amount was only 0.1 ug/l above the minimum detection limit. Since subsequent sampling has been nondetect for 1,1,1-TCA, we believe that the one-time occurrence was an anomaly which sometimes occurs in data analysis. We have also sampled the distribution point prior to the water going to homes and have found no contamination. The water supply is safe at the present time. No one is in direct contact with the City's water and no one is ingesting contaminated ground water.

We do not have specific information about the age of the water lines. The state is receives design information when new water lines are added to the distribution system; however, the lines will be periodically replaced by the City of Republic. The best source of information about the age of water pipes in your area would be the City of Republic.

In general, water lines are under pressure. Water will seep out, but no water will enter the lines because of the pressure. The testing required by the state for community water systems will indicate a problem. One of the tests required is for coliform bacteria. If water is seeping into the lines, the bacteria count will exceed acceptable standards.

Question 16.

One person asked if the Blue Goose or some other purifier machine was considered. He wondered why the agencies didn't try the Blue Goose when it was near Verona, Missouri.

MDNR/EPA Response:

In the initial screening for the feasibility study, we did evaluate thermal destruction. The process options considered were liquid injection, rotary kiln, fluidized bed, multiple hearth, onsite mobile incineration (like the Blue Goose), and offsite RCRA incineration. All of the process options were rejected because they were not feasible for dilute ground water contaminants.

Question 17.

One person asked if we had considered pumping clean water down through satellite wells and up through well Number 1 to dilute the contaminated plume in an attempt to reverse the contamination direction.

MDNR/EPA Response:

This sounds similar to Alternative IV in which the contaminated ground water will be extracted through City Well Number 1 and onsite well REM-1 and reinjected into the deep bedrock aquifer via reinjection wells. The water table will be lowered around the extraction wells, and the reinjected water will raise the water table around the reinjection wells. This will create a water gradient toward the extraction wells since ground water flows downhill from higher water tables to lower water tables. The contaminants will flow with the ground water toward the extraction wells. The extracted water will be air stripped and then undergo carbon adsorption so that the injected water will meet the standards for ground water quality. No contaminants will be reinjected back into the aquifer. This alternative will accelerate the cleanup because the extraction wells alone will reduce the contaminant migration, and the artificial ground water gradient will further reverse the contaminant direction toward them.

Question 18.

A person wanted to know how water is scrubbed.

MDNR/EPA Response:

Scrubbing could refer to either air stripping or carbon adsorption. A well documented and established technology for VOC removal is countercurrent packed tower (CCPT) air stripping. VOC contaminated water is passed through a tower packed with a porous medium and brought in contact with air forced through the tower in a direction opposite to the water flow. A typical air-to-water ratio for VOC removal is 100:1. The porous medium causes an intimate contact between air and liquid, resulting in the VOC being "stripped" from the water and exhausted into the atmosphere. Packing media materials are made of glass, ceramic, or plastic of various geometrical shapes. CCPT air strippers can remove greater than 99 percent of VOC in solutions and are most cost effective when treating large volumes of water.

Carbon adsorption is a conventional treatment process that will remove a broad spectrum of organic compounds from dilute aqueous solutions. The process uses granular activated carbon which attracts the contaminants. As the contaminated ground water passes through the carbon unit, the contaminant will leave the water and adhere to the carbon through a combination of physical and chemical attractions. The contaminant laden carbon will eventually become saturated, or lose its ability to attract additional contaminants, and it must be removed and disposed or regenerated for future use. Regeneration is accomplished by heating the spent carbon at high temperatures to destroy the contaminants.

Question 19.

One citizen asked why this has taken so long when MDNR was asked to take action in 1970, 1971, and 1972, when Solid State Circuits was dumping their wastes in a pond in Christian County and on the farm roads.

MDNR/EPA Response:

The contamination in Republic's drinking water supply was not discovered until early 1983. In June 1982, EPA funded random sampling of municipal water supplies to analyze for synthetic organic compounds. After the contamination was discovered, MDNR took actions to identify the source and both MDNR and EPA initiated removal actions to remove the soil as a continuing source of contamination.

We have followed up on leads provided to us by citizens in the public meeting. The pond in Christian County has already been investigated. The location is southwest of Haseltine Road and Highway FF on the Christian County Line. SSC hauled wastewater to two lined ponds on the former Joe Carroll property. In July 1972, the Springfield Regional Office received a report that the lagoons were leaking. Samples taken from nearby wells and springs in July 1972 showed no contamination. The MDNR has been told that the water, sludge, and liners from the lagoon and the contaminated soils were hauled off to an approved disposal site; however, no documentation exists to verify this. A few years ago, the department sampled nearby wells and the surface soil in the lagoons and detected no contamination. MDNR plans to return to the site and take subsurface samples in the lagoons to verify that no contamination has been left in place.

The farm roads may not have been previously investigated. An official from the MDNR's Springfield Regional office will be contacting the person who asked this question during the public meeting to have her locate the farm roads on a map. We will then be investigating these locations.

It is important to note that both activities do not affect the investigation results or decision process related to this Record of Decision. Any actions required for the pond in Christian County or the farm roads will be conducted independent of the activities selected in this ROD.

Question 20.

Several citizens stated that Solid State Circuits should have to pay a higher rate to use the POTW than the citizens of Republic. Currently, the residents pay $2.05 per 1000 gallons and SSC has negotiated a rate of $1.25 per 1000 gallons.

MDNR/EPA Response:

MDNR and EPA are not parties to this agreement between the City of Republic and Solid State Circuits. It is our understanding that the 1986 agreement allows SSC to discharge effluent from the site to the sewer system was recently amended by an unanimous vote of the City Board of Aldermen on June 12, 1989. The reduced rate of $1.25 per 1000 gallons was included in the second supplemental agreement. As stated in the response to Question 2, the SSC discharge is very unlike the sewer discharge coming from domestic and commercial sources.

Question 21.

One person asked about the integrity of the sewer lines. He commented that we may spread the VOC contamination all over town because the lines leak.

MDNR/EPA Response:

This is a concern of both Agencies. The adequacy of the lines to convey the treated effluent for the duration of the remedial action is uncertain. New sewer lines with larger capacities exist within 2,600 feet of the site. Moving the location where the effluent enters the sewers may alleviate some of this uncertainty. This will be evaluated during remedial design. Additionally, we have concerns about the capacity of the sewer lines during heavy rainstorms. Flow depth monitoring equipment will be installed in the discharge sewer manholes so that the site discharge will be halted during periods of high sewer flow.

Question 22.

One person asked if we had identified any private wells in the vicinity of the site, and if they were contaminated.

MDNR/EPA Response:

Private well surveys were conducted in July 1987 and May 1988. A total of 155 individual properties were included in the survey. The survey area included a 1,000 foot radius centered around the site. The initially proposed survey area was expanded somewhat, based on street and block definition. The survey area was later expanded to include all property immediately adjacent to Main Street south to Highway 60. Page 2-89, Figure 2.24, of the RI report is a map which shows the private well survey area. Only one existing private well was identified as currently accessible. The well is located at 129 South Main Street and is approximately 20 feet deep. Page 3-126, Figure 3-52, of the RI shows the location of the private well identified in the private well survey. The property owner reported that the well was no longer used. The well was sampled on March 7, 1988, and the TCE concentration was 2.9 ug/l. Many respondents reported that they used to have a well on their property, but the wells have since been filled in or covered by home expansions or driveways. All properties included in the survey are serviced by the City of Republic's water and sewer system.

Question 23.

There were several questions asked about the levels of TCE remaining in onsite soil after removal actions. One person said he had read in reports that 4,900 ug/kg TCE still remained at the excavated basement location.

MDNR/EPA Response:

This is true. It was not possible to excavate the contaminated soil completely due to site constraints of excavating to bedrock and encountering the unconsolidated/fractured shallow bedrock aquifer. The greatest soil contamination has been found at the subsurface close to the bedrock. We believe that the contaminated ground water is the source of the soil contamination at the lower depths, since ground water VOC concentrations are five or more times greater than the soil VOC concentrations.

At other sites in Missouri, the Department of Health has established a safe soil level of 70 milligrams/liter, or 70,000 ug/l for TCE. This means that at levels below the safe soil level, a person can live on the site, his children can sit on the surface soil and eat the soil through their normal play activities. The contamination remaining onsite is well below the safe soil level, and it does not appear at the surface. Additionally, the Solid State Circuits site was placed on the Registry of Confirmed Abandoned or Uncontrolled Hazardous Waste Disposal Sites in Missouri on February 22, 1985. The department will be approving changes in use of the property as long as it remains on the Registry. Any change, which adversely impacts the remediation, will not be approved.

Question 24.

A question was asked about the reliability of data generated by Solid State Circuits, Inc.

MDNR/EPA Response:

As stated in the public meeting, the agencies have no reason to distrust SSC's data. We have approved their sampling plans and procedures, have reviewed quality assurance/quality control information for the laboratories they have selected for analytical services, and have observed their sampling procedures personally. Additionally, we have randomly taken split samples and submitted them to our laboratories for independent analysis. We have given SSC audit, or control samples, with concentrations known only by the agencies to see how well SSC's laboratory achieved the known values. The splits and audit sample results have compared favorably to agency results. We did not detect any problems with the data generated by SSC. Additionally, for the RI/FS, SSC personnel did not perform the sampling and analysis themselves. Rather, SSC engaged the professional services of firms with expertise and experience in the field of ground water remediation.

Question 25.

One person asked about a Total Organic Carbon (TOC) NPDES limit for the POTW.

MDNR/EPA Response:

This method measures all of the carbon in a sample. The usefulness of the carbon measurement is in assessing the potential oxygen-demanding load of organic material on a receiving stream. This statement applies whether the carbon measurement is made on a sewage plant effluent, on industrial waste, or on water taken directly from the stream. The TOC test does not differentiate between toxic and nontoxic forms of carbon. The state uses TOC as an indicator parameter and does

not usually have a specific TOC limit in the NPDES permit. The NPDES permit for the POTW at Dry Branch does not have a TOC final effluent limitation.

Question 26.

One person asked if we had looked at land applying the treated effluent coming out of the air strippers. One beneficial use might be to provide pipelines to farms so the water could be used for irrigation.

MDNR/EPA Response:

This is a valid comment. According to 10 CSR 20-7.015, Effluent Regulations, discharges to losing streams shall be permitted only after other alternatives including land application, discharge to a gaining stream and connection to a regional wastewater treatment facility have been evaluated and determined to be unacceptable for environmental and/or economic reasons. We have not selected Alternative III as the remedy for the site, so a detailed analysis of land application has not been conducted. On the surface, it appears that land application would be more expensive than Alternative II since pipelines to farms would need to be constructed. The additional treatment technologies of metals removal and carbon adsorption may be needed before the treated water could be land applied. This would greatly increase the cost.

Question 27.

The United States Department of the Interior (DOI) asked questions about Alternative III which discharges the treated water into Shuyler Creek. The creek (also known as Skeggs Branch) flows southeasterly into the Wilson's Creek National Battlefield where it merges with Wilson Creek. It is the most significant tributary stream within the boundaries of the Battlefield. USDOI was concerned about how Alternative III would affect the water quality of Shuyler Creek. Among their concerns:

a) The proposed discharge into Shuyler Creek would nearly double the low water flow of this stream over an extended period of time. How would this increased flow affect the creek's aquatic life?

b) How would the array of chemical constituents (such as alkalinity, pH, major cations and ions) in the treated water differ from the current chemical constituents of Shuyler Creek? How would aquatic life be affected?

c) What would the temperature of the treated water be and how would this affect aquatic life?

d) Hundreds of thousands of visitors from all over the world visit Wilson's Creek National Battlefield. Based on regional growth and Battlefield development, this visitation is expected to rise substantially in the future. Many of our visitors come into close and/or direct contact with Shuyler Creek. The park's Tour Road crosses the creek and a major park trail fords the creek. What are the potential environmental health hazards associated with any residue of known toxins in the water?

MDNR/EPA Response:

Shuyler Creek is not classified in Missouri Water Quality Standards. This means that it does not contain flow or pools in drought conditions, according to surveys. This is consistent with its "losing" stream designation; that is, much of its flow is lost to ground water. However, we understand the stream flows part of the time and supports some aquatic life. Therefore, we require protection against acute toxicity. We do have aquatic life protection numeric limits for a number of constituents. These would also serve as discharge limits, since no dilution flow would be available.

Increased flow from a discharge which meets the acute toxicity standards for aquatic life protection could provide additional habitat and even have a beneficial effect on aquatic life in Shuyler Creek. No impact would be expected on Wilson Creek.

Major irons and pH in the discharge would be required to meet the range of the water quality standard's aquatic life criteria, so the discharge would not be substantially different from natural conditions.

Effluent temperature would be limited per the water quality standards no more than a 5°F change from ambient temperatures and no more than 90°F maximum.

Organic contaminant reduction in the treatment process will be required to achieve pertinent health-based standards, which are the drinking water supply and ground water criteria.

Question 28.

One resident stated in a phone call to MDNR that he had grave concerns about the release of the treated water to Shuyler Creek. He was concerned that the treated release would affect his private drinking well, since Shuyler Creek is a losing stream and the flow goes underground. He remembered that when the old POTW collapsed, releasing raw sewage, private wells were contaminated.

MDNR/EPA Response:

The release of treated water to Shuyler Creek will require an NPDES permit for the discharge. The permit parameters and limits will be established by using state water quality standards for aquatic life protection. Since Shuyler Creek loses its water to ground water, the discharge will meet ground water standards, in case the discharge does travel underground to a private well.

C. Public Participation Process

Question 1.

Several residents requested an extension of the review period.

MDNR/EPA Response:

First, a 22-day public comment period was established from August 14 to September 5, 1989. Ten days had elapsed since the beginning of the public comment period on August 14 until the date of the public meeting, August 24. A full twelve days of review time was still available from August 24 until September 5, 1989. Additionally, the National Contingency Plan establishes a 21-day public comment period. However, in response to the request, the state and EPA did extend the public comment period an additional nine days until September 14, 1989.

D. Costs/Funding Issues

Question 1.

Several people asked who is going to pay for the cleanup.

MDNR/EPA Response:

The Superfund Law stipulates that, whenever possible, Potentially Responsible Parties (PRPs) pay for remedial actions at a Superfund site. PRPs can conduct the remedial action or EPA can take action following the cleanup to recover monies for Superfund.

After the Record of Decision (the remedy selection document) is signed, MDNR and EPA will ask Solid State Circuits, Inc. (SSC) to undertake the design and implementation of the selected remedy. If SSC agrees, MDNR and EPA will enter into a consent decree with SSC similar to the agreement for the remedial investigation/feasibility study.

If SSC decides not to conduct the cleanup, then the cleanup will be funded with federal Superfund money, with the state paying a 10% cost share for the remedial action. The state will assume responsibility for all future operation and maintenance (O&M) costs for the expected life of the remedial action. Both the state and EPA will seek to recover their costs of cleanup and O&M from SSC and other PRPs.

Question 2.

An alderman asked, if Alternative II is selected and the POTW balance is upset, who will pay for a new POTW.

MDNR/EPA Response:

Regardless of the agreement which exists between SSC and the City of Republic, the MDNR and EPA will not release SSC from any legal liability associated with implementing the selected remedy.

Question 3.

One person asked if the "push" for Alternative II wasn't simply a financially effective move by SSC.

MDNR/EPA Response:

Alternative II is the selected cleanup remedy for the site because it represented the best balance, when compared against the nine evaluation criteria, one of which is cost effectiveness. The National Contingency Plan (NCP) specifies the nine evaluation criteria in the decision process for remedial actions at Superfund sites. Cost is also important to the state and to EPA, since it may be necessary to fund the remedy with Federal Superfund monies, with the state providing a 10 percent cost share, in the event that responsible parties elect not to implement the remedy. MDNR and EPA will not compromise on the effectiveness of an alternative to meet the cost-effectiveness criterion. However, among those alternatives considered equally effective, MDNR and EPA select the least costly. This preserves monies for other Superfund sites.

4.0 COMMUNITY RELATIONS ACTIVITIES AT SOLID STATE CIRCUITS SITE

Community relations activities conducted at the Solid State Circuits site to date have included:

MDNR issued a press release announcing that they would be assuming responsibility for the remedial investigation/feasibility study (RI/FS) following the completion of the removal actions (October 8, 1985);

MDNR conducted phone and personal interviews with local officials and interested residents to identify community concerns (February through April 1986);

MDNR prepared community relations plan (October 8,1986);

MDNR prepared and distributed a fact sheet on health effects of site contaminants and details about the cleanup to date (September 1986);

MDNR issued a news release announcing a public meeting on May 4, 1987 to discuss the steps to be taken by the Department and Solid State Circuits during the RI/FS (April 21, 1987);

MDNR prepared and distributed a fact sheet informing the public about the ground water investigation in Republic (May 1987);

MDNR issued a news release announcing that the RI/FS investigation had begun in Republic (June 17, 1987);

MDNR established an information repository at the Greene County Branch-Republic Branch (June 24, 1987);

MDNR prepared and distributed fact sheets summarizing the RI/FS conclusions and the proposed plan (August 1989);

MDNR released the administrative record, which included the RI/FS, and the Proposed Plan for public review and comment (August 14, 1989);

MDNR and EPA held a public meeting at the Republic High School cafeteria in Republic to describe the RI/FS and the proposed plan and to respond to citizens' questions. Approximately 100 people attended, including citizens, elected officials, and technical representatives of the PRPs (August 24, 1989). A transcript of this meeting will be placed in the administrative record file at the Greene County Library - Republic Branch; and,

MDNR and EPA allowed one extension to the public comment period. The comment period began August 14 and was extended to September 14, 1989.

NOTE: This inserted portion includes revisions to the Standards which became effective April 15, 1989. Most of the changes are in Table A, which is reprinted in its entirety.

Table A—Criteria for Designated Uses

I = Protection of Aquatic Life
II = Drinking Water Supply
III = Irrigation
IV = Livestock, Wildlife Watering
V = Whole-Body-Contact Recreation
VI = Ground Water (see subsection (5)(A))
VII = Ground Water (see subsection (5)(B))

Pollutant (ug/l)	I	II	III	IV	V	VI	VII
Chlorine*	10(2)					10(2)	
Cyanide**	5					5	

* measured as total residual chlorine
warm-water and cool-water fisheries—10 ug/l; cold-water fisheries—2 ug/l
**measured as cyanide amenable to chlorination

Pollutant (mg/l)	I	II	III	IV	V	VI	VII
Chloride	*	250					
Sulfate	*	250					
Fluoride		2.2		4		2.2	2.2
Nitrate-N		10				10	10
Dissolved Oxygen (minimum)**	5(6)						
Ammonia-N	***					***	

* see subsection (4)(L)
** warm-water and cool-water fisheries—5 mg/l; cold-water fisheries—6 mg/l
*** see Table B

Pollutant (/100 ml)	I	II	III	IV	V	VI	VII
Fecal Coliform Bacteria					200		

Pollutant (° F)	I	II	III	IV	V	VI	VII
Temperature							
warm-water maximum	90						
cool-water maximum	84						
cold-water maximum	68						
warm-water change	5						
cool-water change	5						
cold-water change	2						

Pollutant (ug/l)	I	II	III	IV	V	VI	VII
(percent saturation)							
Total Dissolved Gases	110%						

The toxic form of metals shall be determined by the following methods: For aquatic life protection (column I and aquatic life numbers in column VI)—Iron and Copper—Dissolved; Mercury—Total Recoverable

Other metals—
As determined by acid soluble analysis when that method becomes approved by the Environmental Protection Agency. Until that method is approved, both the dissolved and total recoverable analysis should be performed.
Drinking water supply—
Total metals in column II and for drinking water supply limits in columns VI and VII.
Other uses—
Total metals for uses designated in columns III and IV.
** Hardness is defined as the total concentration of magnesium and calcium ions expressed as calcium carbonate. For purposes of this rule, it will be determined by the arithmetic average of a representative number of samples from the water body in question or from a similar nearby water body.

Pollutant (ug/l)	I	II	III	IV	V	VI	VII
Metals							
Antimony		146				146	[illegible]
Arsenic	20	50	100			20	[illegible]
Barium		1000				1000	[illegible]
Beryllium	5		100			5	[illegible]
Boron			2000			2000	[illegible]
Cadmium		10					[illegible]

Cadmium, column I:

	Hardness**(mg/l) <125	125—200	>200
chronic toxicity maximum:			
cold-water fishery	[illegible]	1.5	2
lakes	10	10	10
general warm-water fishery	[illegible]	[illegible]	17
limited warm-water fishery	13	[illegible]	22
acute toxicity maximum			
cold water fishery	[illegible]	6.2	[illegible]
lakes & general warm water fishery	[illegible]	[illegible]	72
limited warm water fishery	46	[illegible]	[illegible]

Cadmium, column VI:

	Hardness**(mg/l) <125	125—200	>200
chronic toxicity maximum			
cold water fishery	[illegible]	1.5	2
lakes	[illegible]	[illegible]	10
general warm-water fishery	[illegible]	[illegible]	[illegible]
limited warm-water fishery	13	[illegible]	[illegible]

Pollutant (ug/l)	I	II	III	IV	V	VI	VII
Chromium		50	100				

Chromium, column I:

	Hardness**(mg/l)
chronic toxicity maximum	
lakes	[illegible]
cold water fishery, general warm-water fishery	42
limited warm-water fishery	190
acute toxicity maximum	
lakes	[illegible]
cold-water fishery, general warm water fishery	[illegible]
limited warm water fishery	[illegible]

Chromium, column VI:

	Hardness**(mg/l)
chronic toxicity maximum	
lakes	[illegible]
cold-water fishery general warm water fishery	42
limited warm-water fishery	[illegible]

Pollutant (ug/l)	I	II	III	IV	V	VI	VII
[illegible]				[illegible]		[illegible]	[illegible]
Copper		1000		500			[illegible]

Copper, column I:

	Hardness**(mg/l) <125	125—200	>200
chronic toxicity maximum			
lakes, cold water fishery, general warm-water fishery	[illegible]	29	37
limited warm-water fishery	30	43	55
acute toxicity maximum			
lakes, cold water fishery general warm-water fishery	30	45	58
limited warm-water fishery	46	67	[illegible]

Copper, column VI:

	Hardness**(mg/l) <125	125—200	>200
chronic toxicity maximum			
lakes, cold water fishery, general warm-water fishery	[illegible]	29	[illegible]
limited warm water fishery	30	43	55

Pollutant (ug/l)	I	II	III	IV	V	VI	VII
Iron	1000**	300				300	300

		<125	125—200	>200	[col]	[col]	[col]		<125	125—200	>200	[col]
Lead					50							50
	Hardness**(mg/l)							Hardness**(mg/l)				
	chronic toxicity maximum,							chronic toxicity maximum,				
	all classified waters	[illegible] µg/l	20	29				all classified waters	[illegible] µg/l	20	29	
	acute toxicity maximum											
	all classified waters	[illegible] µg/l	130	190								
Manganese					50		50					50
Mercury					2							2
	Hardness **(mg/l)							Hardness **(mg/l)				
	chronic toxicity maximum							chronic toxicity maximum				
	all classified waters	[illegible] µg/l						all classified waters	[illegible] µg/l			
	(same as existing criterion)											
	acute toxicity maximum											
	all classified waters	2.4 µg/l										
Nickel						200						[illegible]
	Hardness**(mg/l)							Hardness**(mg/l)				
	chronic toxicity maximum							chronic toxicity maximum				
	lakes	[illegible] µg/l	220	280				lakes	[illegible] µg/l	220	[illegible]	
	cold water fishery							cold water fishery,				
	general warm-water fishery	360	500	650				general warm-water fishery	360	[illegible]	[illegible]	
	limited warm-water fishery	425	600	770				limited warm-water fishery	425	[illegible]	[illegible]	
	acute toxicity maximum											
	lakes	1400 µg/l	2000	2500								
	cold-water fishery											
	general warm-water fishery	3200	4600	5800								
	limited warm-water fishery	3800	5400	6900								
Selenium	10				10		10					10
Silver					50							50
	Hardness**(mg/l)							Hardness**(mg/l)				
	chronic toxicity maximum,							chronic toxicity maximum:				
	all classified waters	.12 µg/l						all classified waters	[illegible] µg/l			
	Hardness**(mg/l)											
		<125	125—200	>200								
	acute toxicity maximum											
	all classified waters	4.1 µg/l	[illegible]	13								
Thallium					13		13					
Zinc					5000.	2000						2000
	Hardness**(mg/l)							Hardness**(mg/l)				
		<125	125—200	>200					<125	125—200	>200	
	chronic toxicity maximum,							chronic toxicity maximum,				
	cold water fishery	175 µg/l	240	310				cold-water fishery	175 µg/l	240	[illegible]	
	lakes	105	150	190				lakes	105	150	190	
	general warm-water fishery	245	345	440				general warm-water fishery	245	345	440	
	limited warm-water fishery	1065	1505	1920				limited warm-water fishery	1065	1505	1920	
	acute toxicity maximum											
	cold water fishery	190 µg/l	270	345								
	lakes	115	165	210								
	general warm water fishery	270	380	490								
	limited warm-water fishery	1160	1660	2120								

* The toxic form of metals shall be determined by the following methods.
For aquatic life protection (column I and aquatic life numbers in column VI)—
Iron and copper dissolved; mercury—total recoverable

** Hardness is defined as the total concentration of magnesium and calcium ions expressed as calcium carbonate. For purposes of this rule, it will be determined by the arithmetic average of a representative number of samples from the water body in question or from a similar nearby water body.

Other metals—
As determined by acid soluble analysis when that method becomes approved by the Environmental Protection Agency. Until that method is approved, both the dissolved and total recoverable analysis should be performed.

Drinking water supply—
Total metals in column II and for drinking water supply limits in columns VI and VII

Other uses—
Total metals for uses designated in columns III and IV.

Pollutant (ug/l)	I	II	III	IV	V	VI	VII
Organics ug/l							
Acenaphthene		20				20	20
Acrolein		320				320	320
Bis-2-chloroisopropyl ether		35				35	35
2,4-dichlorophenol	7					7	
Ethylbenzene	320					320	
Hexachlorocyclopentadiene	.5					.5	.5
Isophorone		5200				5200	5200
Nitrobenzene		30				30	30
2-chlorophenol		.1				.1	.1
Phenol	100	1				100	100
Dichloropropene		87				87	87
Fluoranthene		40				40	40
Para-dichlorobenzene		75				75	75
Other Dichlorobenzenes		400				400	400
1,1,1-trichloroethane		200				200	200

Pollutant (ug/l)	I	II	III	IV	V	VI	VII
Pesticides ug/l							
Demeton	.1					.1	
Endosulfan	.056					.056	
Guthion	.01					.01	
Malathion	.1					.1	
Parathion	.04					.04	
2,4-D		100				100	100
2,4,5-TP		10				10	10
Chlorpyrifos		.033				.033	.033

Pollutant (ug/l)	I	II	III	IV	V	VI	VII*
Persistent, Bioaccumulative, Man-made Toxics* ug/l							
PCB's	.000079					.000079	.000079
DDT	.000024					.000024	.000024
endrin	.0023	1.0				.0023	1.0
aldrin	.000079	.000074				.000074	.000074
dieldrin	.000076	.000071				.000071	.000071
heptachlor	.0038	.00028				.00028	.00028
methoxychlor	.03					.03	
mirex	.001					.001	
toxaphene	.000073	.00071				.00071	.00071
lindane (gamma-BHC)	.062	.0022				.0022	.0022
Alpha,Beta,delta-BHC	.0074	.0022				.0022	.0022
chlordane	.00048	.00046				.00046	.00046
benzidine	.00053	.00012				.00012	.00012
2,3,7,8-TCDD (dioxin) (ng/l)**	.000014	.000013				.000013	.000013
pentachlorophenol***	pH						
	3.2 ug/l at pH 6.5					3.2	
	5.3 ug/l at pH 7.0					5.3	
	8.7 ug/l at pH 7.5					8.7	
	14 ug/l at pH 8.0					14	
	23 ug/l at pH 8.5					23	
	39 ug/l at pH 9.0					39	

	I	II	III	IV	V	VI	VII
Persistent, Man-made Carcinogens* ug/l							
Acrylonitrile		.058				.058	.058
Hexachlorobenzene		.00072				.00072	.00072
Bis (2-chloroethyl) ether		.03				.03	.03
Hexachloroethane		1.9				1.9	1.9
3,3'-dichlorobenzidine		.01				.01	.01
Hexachlorobutadiene		.45				.45	.45
n-nitrosodimethylamine		.0014				.0014	.0014

*Many of these values are below current detection limits; analyses will be determined by the latest edition of *Standard Methods* or the most current analysis method approved by the Environmental Protection Agency.
**Units for dioxin = nanograms liter (ng l) 1 ug l = 1000 ng l
*** Toxic impurities may be present in technical-grade pentachlorophenol; monitoring and discharge control will assure that impurities are below toxic concentrations.

Pollutant (ug/l)	I	II	III	IV	V	VI	VII
Volatile Organic Chemicals* ug/l							
Chlorobenzene		20				20	20
Carbon Tetrachloride		5				5	5
Halogenated methanes		0.19				0.19	0.19
1,2 dichloroethane		5				5	5
1,1-dichloroethylene		7				7	7
Trichloroethylene		5				5	5
Tetrachloroethylene		0.8				0.8	0.8
Benzene		5				5	5
Vinyl chloride		2				2	2

*These criteria apply at water supply withdrawal points. Analyses will be determined by the latest edition of *Standard Methods* or the most current analysis method approved by the Environmental Protection Agency.

TABLE G--LAKE CLASSIFICATIONS AND USE DESIGNATIONS

--Busch W.A. #41 should be #35
--Jackass Bend and Lawson City Lake are classified L3 instead of L2

TABLE H--STREAM CLASSIFICATIONS AND USE DESIGNATIONS

--An additional listing for the River des Peres includes 1 mile of Class C stream, from Hwy. 267 to Morganford Road and an x in the LWW and AQL columns
--Squaw Cr. Ditch, 8 miles of Class P stream in Basin 11, is deleted